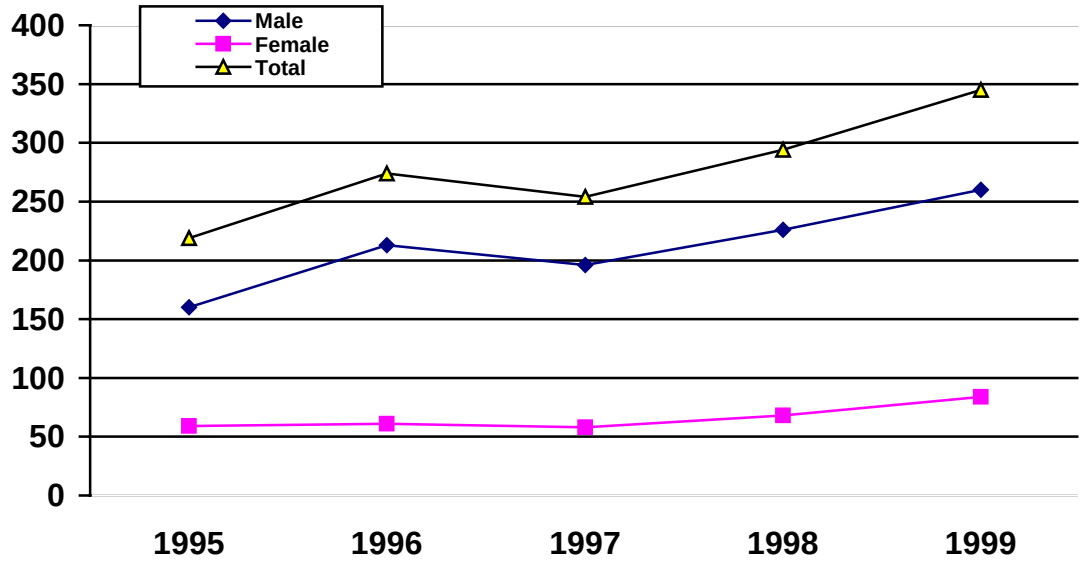
HEAD INJURY

1386 patients were admitted to Liverpool Hospital during 1995-1999 with the diagnosis of head injury. The causes are shown in box 1.

Box 1 – Causes of head injury at Liverpool Hospital 1995-7

Motor Vehicle Accidents	
- Car Occupants	30.6%
- Motor Cyclists	6.85%
- Pedestrians/Cyclists	18.7%
Falls	19.5%
Assault	16.0%
Industrial accidents	2.16%
Others	6.2%

South Western Sydney Area Health Services' Trauma Registry shows that between 1995-1999, 1055 (76.1%) of patients admitted with head injury were male and 331 (23.8%) were female (see graph). The average age of head injured patients was 33 years, however the patients ranged from newborn up to 93 years of age. Almost 30% of patients with a head injury had some sort of residual disability requiring home help or rehabilitation.



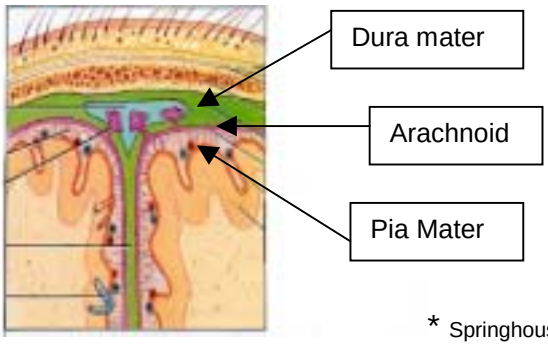
What is a head injury?

A head injury is an injury to the brain, the skull or to the face. Head injury varies significantly in severity, and no two injuries are the same. There are two basic groups that brain injury divides into: primary and secondary. Primary brain injury is the initial insult that occurs when the head hits the windscreen during the car accident. Secondary brain injury occurs later, for example when a person involved in a car crash is not able to breathe effectively the injured brain is starved of oxygen.

BRAIN STRUCTURE AND FUNCTION

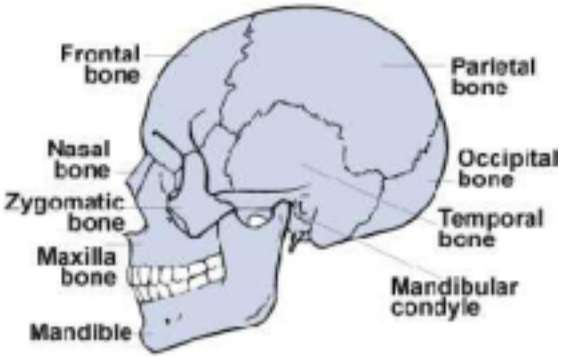
The lower regions of the brain control subconscious activities (things that occur automatically without us thinking about it), for example blood pressure regulation, respiratory rate, posture and balance. At the highest level, the brain integrates conscious activities (things that occur when you think about it), such as abstract thinking, learning and memory.

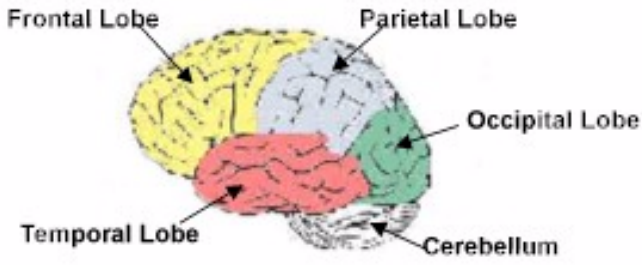
The meninges are three layers of tissue cover the brain and spinal cord. The pia mater is closely attached to the surface of the brain, and is covered by the arachnoid. Between the arachnoid and the dura mater is cerebrospinal fluid. This helps to protect the brain when energy is transferred during injury. The fluid is normally clear and colourless, and is manufactured within the brain. It is within these three layers that some of the bleeds you read about below can occur.



* Springhouse Corporation

Cerebrum – this is responsible for sensory (for example hearing) and motor functions (for example writing) as well as the higher mental functions. It is divided into two cerebral hemispheres. Each hemisphere controls the sensory and motor functions of the other side of the body.
The cerebral hemispheres are divided into 4 lobes (see the picture below). These are the frontal lobes, the parietal lobes, the temporal lobes and the occipital lobes. Each set of lobes is responsible for many things. Basic responsibilities are listed below.





Frontal lobes - short-term memory, emotions, intellect, speech and personality.

Temporal lobes - hearing, long term memory, intellect and personality.

Parietal lobes - sensory interpretation (sight, hearing, touch, taste and smell), and how we relate to the environment.

Occipital lobes – sight.

Deep in the brain where the cerebral hemispheres meet is the **diencephalon.** This contains many important structures: the epithalamus, thalamus, hypothalamus and subthalamus. Their functions include regulating body temperature (by shivering and sweating) and blood pressure, and controlling anger and rage.

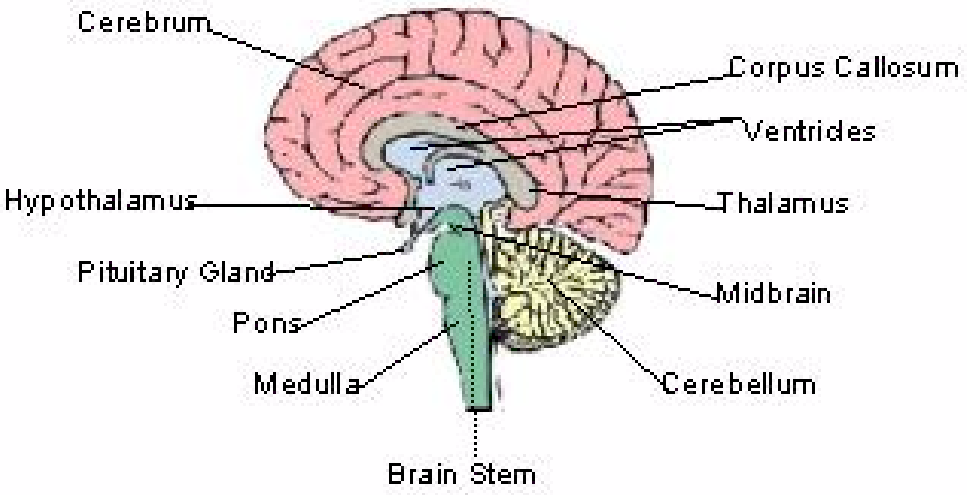
Cerebellum – the 2nd largest part of the brain. Assists with balance, coordination, posture and skilled movements.

The brainstem - situated at the base of the brain where the spinal cord joins, this is divided into three areas – the midbrain, the pons and the medulla. The brainstem is has many functions, mostly subconscious. It controls activities such as sleep and wakefulness, breathing, blood pressure and heart rate. Some specific tasks of these areas are listed below.

Midbrain – sends messages from the cerebrum to the cerebellum and spinal cord and regulates hearing and sight reflexes.

Pons – sends messages from the cerebrum to the cerebellum about the body's voluntary movements.

Medulla – holds reflex centres that assist regulation of heart rate, respiratory rate, swallowing, coughing, sneezing, and hiccupping.



TESTS PERFORMED ON HEAD INJURED PATIENTS

Electroencephalogram (EEG) – the brain cells generate millions of tiny electrical impulses. These impulses combine to create brain waves. Electrodes painlessly placed on the scalp detect these brain waves. EEG's are performed to test if the brain waves are normal or not. Abnormal wave patterns can indicate seizures and damage from trauma.

Cerebral CT scan – a computer uses x-rays to produce cross-sections or slices of the head. It picks up bleeding and damage to the brain that would not show up on normal x-rays. Like an x-ray, a CT scan does not hurt but the patient must lie still for a few minutes.

This is a photo of one of the CT scanners at Liverpool Hospital.
The patient is put on the table and it moves in and out depending on what needs to be scanned. Any part of the body can be scanned.

X-rays – X-rays of the chest, pelvis and neck are standard in all patients brought to hospital with anything more than minor trauma. Separate x-rays of the skull are rarely taken now as the CT scan gives much more information.

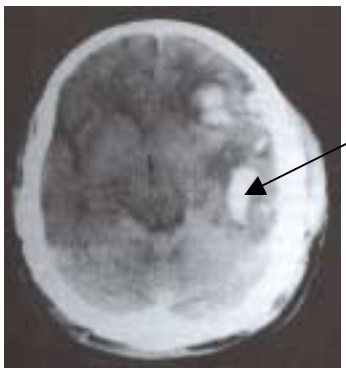
PRIMARY BRAIN INJURY

There are many types of primary brain injury that affect different parts of the brain. Each injury varies in severity and potential outcome. Injuries usually appear in combination rather than separately.

Contusions

This is bruising and sometimes laceration of the brain tissue. They are the most common form of brain injury, and can be associated with brain swelling and ongoing brain dysfunction.

Common Causes - Contusions are caused by blunt trauma and are often seen as coup and contre-coup injuries. The coup (pronounced “coo”) is the injury that occurs at the site of impact. The contrecoup (pronounced “con-tra-coo”) is the injury that occurs on the opposite side. This happens because the skull is rigid and the brain is the consistency of jelly. Therefore the brain can move back and forth within the skull when struck, creating either or both injuries.



Cerebral CT scan showing brain contusions

Diagnosis – this is made on a CT scan. The patient’s signs and symptoms depend on the location and severity of the contusion. Because contusions affect the lobes of the brain, the symptoms each patient may experience are different. An injury to the frontal lobes, for instance, can create problems with

behaviour and emotions, whereas a contusion to the temporal lobe may mean the patient develops difficulty with long-term memory.

Treatment - there is no operation that can remove the contusions. Like a bruised knee, there is to do except to try to alleviate the swelling and rest. The patient will usually be under sedation and on the Intensive Care Unit, where they will be nursed at a slight head-up angle to allow swelling to drain.

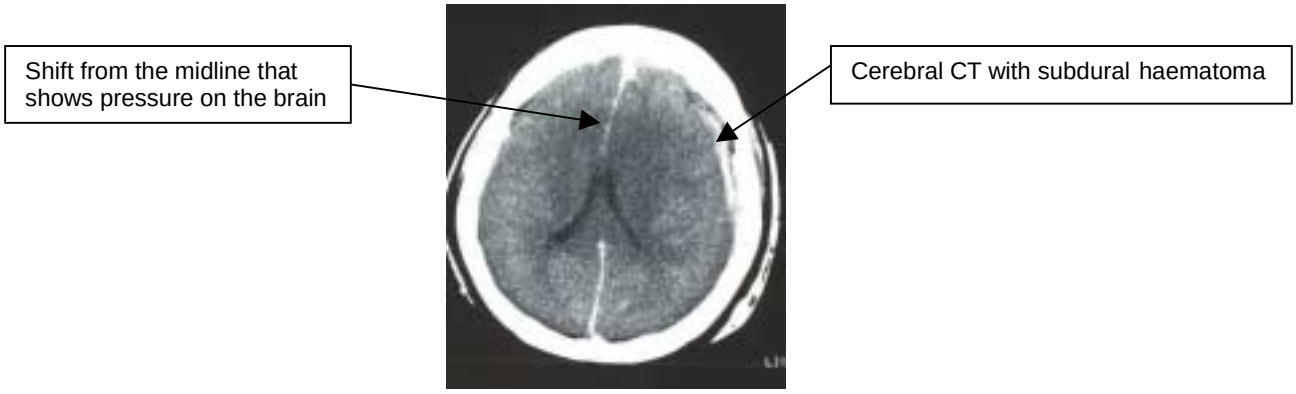
Complications – swelling can cause further damage by crushing healthy brain. Doctors may decide to monitor the pressure inside the head (intracranial pressure monitoring). If the pressure is rising and not controlled by drug treatment a surgeons may need to do a craniectomy or insert an extra-ventricular drain.
The brain is extremely complex and it is not always forgiving after an injury. Patients with brain contusions will often have been knocked out and are often symptomatic after the injury. Contusions may not visible on the initial CT scan and may develop over the following days. The doctors will treat the patient as a whole and deal with individual symptoms as they present. The main problem with contusions is the length of time they can take to get better. Unlike the other head injuries in this booklet, contusions are not treated by operation, and so healing can take longer and is not always complete.

Outcome – the final outcome is very dependent on the severity and location of the contusions. Patients, who are not unconscious after the injury, and those under 50 years of age have the highest chance of a full recovery.

Sub-dural Haematoma

This is bleeding in the space between the dura mater and the arachnoid (see the picture for details). Veins bridging the space tear resulting in bleeding and clot formation. Sub-dural haematomas can form within 72 hours of injury (acute), up to ten days (subacute) or over longer (chronic). The elderly and heavy drinkers are particularly susceptible to chronic sub-dural bleeding.

Common causes – the bridging veins can be torn by sudden acceleration or deceleration. Typical causes are falls, assaults, and motor vehicle crashes.



Diagnosis – this made by CT scan.

Treatment - If the bleed is large, a neurosurgeon performs a craniotomy or craniectomy to remove the clot and stop the bleeding. Small haematomas do not always need an operation but the patient is closely observed and may have repeat CT scans to ensure the clot is not growing. After the operation the patient will be looked after on the Intensive Care Unit.

Complications - Brain swelling, which increases the intracranial pressure and can damage healthy brain, can occur. The bleeding may continue after the operation and re-accumulate. There may be a delayed bleeding into the brain, and these patients may be prone to seizures.

Outcomes - The acute subdural haematoma (the most common one) carries the highest rates of death – approximately 60-90%. Reasons for this are

- The extensive damage as a result of the injury
- Associated brain swelling
- High intracranial pressures from the injury.

The best outcomes are associated with short times from injury to operation (less than 4 hours), normal intracranial pressure, good levels of consciousness and short periods of unconsciousness.

Extra-dural Haematoma

These are called in epidural haematomas in North America. An extradural haematoma is a bleed between the dura and the skull, usually from an artery travelling through this space.

Common causes – extra-dural haematomas are caused by blunt trauma - falls, assaults and traffic accidents. The classic cause is the result of a fracture of the skull just above the ear – the temple. The broken skull lacerates the underlying layers and an important artery, which bleeds rapidly. This creates a big blood clot that puts pressure on the rest of the brain.

Diagnosis – some patients may be unconscious from the time of injury, others may be knocked out only briefly or not at all and can seem well. A couple of hours later, these people may start displaying symptoms such as

increasing headache, nausea and vomiting and become unconscious. They may not survive unless they have an emergency operation.

Treatment - a neurosurgeon performs a craniotomy or craniectomy to remove the clot and stop the bleeding. The patient will spend the post-operative period on the Intensive care Unit. Smaller haematomas may not need an operation but the patient is closely observed and may have repeat CT scans to ensure the clot is not growing.

Complications - the main problem with an extra-dural haematoma is the "lucid period". This is the time immediately post injury when the patient may appear well apart from a headache, thereby falsely reassuring everyone. Increasing headache, nausea, vomiting, drowsiness and confusion are all concerning features that should be checked in hospital urgently.

Outcomes – compared to other brain injuries, promptly treated extra-dural haematomas have a better probability of a good outcome, other injuries allowing. As with all brain injuries, a period of recovery and rehabilitation will probably be required and even though the patient may make a full functional recovery there may be residual problems with concentration and memory.

DIFFUSE AXONAL INJURY (DIA)

This is the most severe form of brain injury. Diffuse axonal injury does not have a single focal point of trauma but many. Microscopic damage and bleeding is spread throughout the brain with widespread consequences for function and long-term recovery.

Common Causes - severe diffuse axonal injury almost exclusively occurs in high speed motor vehicle collisions. The extreme energy transferred sets up shearing forces between different cells and parts of the brain. Another name for DAI is "a shaken brain".

Diagnosis – DAI is often difficult to see on CT scan and can appear normal despite the patient being unconscious. Mild DAI causes a coma of 6-24 hours in duration. Moderate DAI is more common, and results in a coma lasting more than 24 hours. Severe DAI is characterised by deep and prolonged coma (for weeks to months).

Treatment – there is no specific treatment of DIA as the damage is microscopic and throughout the brain. The aim is to treat the patients other injuries and give the brain the best possible environment in which to heal itself.

Outcome – this depends on the severity of the DIA and any other injuries. Patients with mild DAI recover consciousness within 24 hours, and moderate after this time. Those with severe DAI who regain consciousness will usually do so in the first 3 months post injury. Although patients regain consciousness complete recovery may take longer and indeed may never be reached.

Sub-arachnoid Haemorrhage

This is bleeding between the pia mater and the arachnoid layers of the meninges, and is the same layer where the cerebrospinal fluid is located. Some sub-arachnoid haemorrhage is often found in serious head injury, and is a sign of increased damage. Traumatic sub-arachnoid haemorrhage rarely needs treatment in its own right beyond treating the patient's other injuries as well as possible.

Concussion

Concussion is the mildest form of head injury in which there is brain injury as well. The patient may or may not lose consciousness but will not be able to remember the injury. This amnesia may extend to events immediately before and after the injury as well but is transient and reversible. The patient may also have headache with nausea and vomiting. There is microscopic damage to the brain but on a much smaller scale than in DAI. The brain will fully recover from concussion but repeated episodes can be cumulative and eventually result in noticeable loss of function. There is no specific treatment for concussion other than rest. Physical exertion and contact sports should be avoided for at least three weeks following concussion.

SECONDARY BRAIN INJURY

The brain makes up only 2% of adult body weight but receives almost 25% of the blood volume as its requirements for oxygen and glucose are so high.

The skull is like a closed box with three contents – brain, blood, and cerebrospinal fluid (CSF). Pressure within the skull, or intracranial pressure (ICP) depends on the amount of blood and CSF as the size of the skull and the volume of brain cannot vary. If injury causes bleeding or swelling within the brain the pressure will start to rise. This pressure will squash healthy brain and reduce the blood flow to the brain – both of which cause further damage.

The body will try to adjust and reduce the pressure by reducing the amount of CSF. However this mechanism is quickly exhausted if no treatment is instituted, or if the brain injury is too severe. As the pressure continues to rise it starts to force the brain out of the skull down through the opening for the spinal cord at the base of the skull. Almost all patients who have reached this stage will die.

Too much or too little fluid or carbon dioxide in the blood stream may also cause secondary brain injury. The aim of the medical team is to normalise the situation by replacing lost blood without giving any extra and by assisting the patient with breathing if necessary.

This patient has signs of increased intracranial pressure. When the brain compresses against the skull wall, it compresses the nerve that changes the size of the pupil – that is why this patient's pupils are unequal

TREATMENT FOR HEAD INJURED PATIENTS

ICP Monitor – this is inserted through the skull and measures the pressure inside the head. High intracranial pressure decreases the blood supply of the brain, and can eventually result in death or severe brain injury. An ICP monitor is commonly put in after surgery on the brain, or if the head injury is severe but does not currently need operation. The monitor allows medical and nursing staff to check that an adequate blood supply to the brain is maintained. In addition a rising ICP is a warning that further bleeding or swelling is taking place in the brain, which needs further investigation and treatment.

This is an extra-ventricular drain.
This drain goes into the brain and sits in one of the ventricles where the cerebrospinal fluid circulates. When the pressures inside the skull are high, some of the cerebrospinal fluid is drained out into the chamber. This decrease in cerebrospinal fluid within the skull gives more room for the brain to swell.

Extra-ventricular Drains – a drain allows cerebrospinal fluid to move from inside the head. This lowers the ICP and thereby improves blood flow and reduces damage.

Burr-hole – this is a hole made in the skull by a neurosurgeon to remove a sub-dural or extra-dural haemorrhage. A special drill is used to cut the hole in the skull.

Craniotomy – this is a more extensive procedure than a burr-hole. The neurosurgeon takes a large piece of skull, and folds it back like a flap. After the blood clot is evacuated and any bleeding stopped, the skull is closed back over before the skin is stitched.

Craniectomy – as in a craniotomy, the neurosurgeon raises a flap of skull. However the piece of bone is removed and left out when the operation is over

and the skin is closed. This gives the brain more room to expand without becoming squashed. The piece of bone that is removed is sent to a bone bank for storage. After about 6 weeks to a few months, the patient then has a cranioplasty. This replaces the stored bone or uses artificial bone in its place.

Endotracheal Tube – if a patient has a severe head injury, their level of consciousness deteriorates. When this happens, the patient may not be able to breathe without assistance because the tongue, vomit or blood can block the airway. To keep an open airway and assist the patient with breathing, an endotracheal tube is passed into their mouth and throat then down their trachea (windpipe).

Tracheostomy – this is a tube that is inserted into the trachea through the neck bypassing the mouth. A tracheostomy is used if a patient has had an endotracheal tube for several days and is likely to need continued help with breathing. Insertion is a quick surgical procedure that is carried out on sedated patients only.
If a patient has severe facial injuries inserting an endotracheal tube may be difficult. In these emergency cases a procedure similar to a tracheostomy may be needed to provide an airway. This is done higher in the neck just below the Adam's apple and is called a cricothyroidotomy.

COMMON QUESTIONS

What is a “coma”?

A coma is a very low level of consciousness. The patient is not aware of their surroundings, cannot speak or make sounds and does not respond to a painful stimulus (like a blood test) by opening their eyes or moving.

What happens when the patient leaves hospital?

If the patient has a minor head injury, they may be discharged from the Emergency Department with a head injury advice card. This card gives a range of signs that indicate if the head injury is getting worse. It also gives a contact number, or advises the patient with the head injury to return to the Emergency Department that they had attended.

If the person has been admitted and is ready for discharge, a follow up appointment with the admitting doctor may be organised. This appointment is routinely organised for patients for 1-2 weeks post discharge from our hospital here at Liverpool.

I am caring for someone with a head injury and I need help! What can I do?

Carers are sometimes just as in need of support as those who have had a head injury. At the end of this document you will find a list of web-links that may be of help. If not, your local doctor or Brain Injury Unit may be able to offer suggestions to assist.

BETTER PRACTICE GUIDELINES

Better Practice Guidelines are available on a number of health related issues. These guidelines are compiled with the assistance of expert advice and research on the topics under scrutiny.

There is a collection of practice guidelines from various international sources on brain injury. One such guideline is from Eastern Association for the Surgery of Trauma (EAST) in the USA and has been published in the Journal of Trauma (November 2001). The American Association of Neurologic Surgeons have also published practice guidelines for the management of severe brain injury also in the Journal of Trauma (April 2001).

FACILITIES AT LIVERPOOL HOSPITAL

Intensive Care

The Intensive Care Unit consists of 22 beds. Seriously ill patients receive one-to-one nursing. Specialist doctors with expertise in caring for ill patients with complex needs provide the medical care. Patients who have suffered major abdominal trauma may be admitted to this unit for further treatment and monitoring before or after operation.

Ward

The Trauma, Orthopaedics and Plastics ward where most of the patients with abdominal injuries are admitted is on the third floor of the clinical building. The ward has 40 beds, with a staff ratio of one nurse to five patients. The phone number for the ward is (02) 98283103.

Social Worker

Liverpool Hospital has social worker facilities provided throughout the duration of hospital stay. A social worker is alerted to the arrival of a trauma patient in the Emergency Department, and will provide any necessary assistance.

For the rest of the hospital stay, social work cover and help is available in Intensive Care, the ward and the Brain Injury Unit. Social workers will also assist in the completion of Workcover and sick entitlement forms.

Brain Injury Unit

The Brain Injury Unit is part of Liverpool Hospital, and admits head-injured patients for rehabilitation. Some patients will be admitted for a short period, others have been known to stay a year. Length of stay depends on the type and severity of the head injury, and the progress of the patient. The team that work in the Brain Injury Unit are multidisciplinary – which means that they are from a variety of speciality areas including physiotherapy, speech therapy and occupational therapy. Each member of the team spends time with the patients

to assist them in regaining functional levels in normal activities. The overall objective of the unit is to assist the patient achieve the fullest level of independence possible.

The Brain Injury Unit also has an Outpatients facility, whereby people can make an appointment to see one of the doctors from the unit to be assessed for their previous head injury. These doctors can assist with ideas on minimising the effects of the head injury, and can determine if there are any further rehabilitation that they may be able to assist with.

OTHER INFORMATION

Health at Yahoo

Health at Yahoo provides a dictionary of medical terms with easy to understand answers.
www.health.yahoo.com

LINKS, ORGANISATIONS AND SUPPORT GROUPS DEALING WITH HEAD INJURY

Access Brain Injury Services.
This is a website that offers consultative and rehabilitation services for those who have traumatic brain injury. It is based in New South Wales, Australia.
www.accessbis.com.au

The Brain Injury Association of NSW.
This is a major association for New South Wales, Australia. There is no webpage available to view, but below is an email address that can be used to receive consultative advice.
Email:mail@biansw.org.au

Head East.
This Benevolent Society is based in Campbelltown, New South Wales. The website provides information on a number of general health educational activities that can be undertaken. It also discusses its current assistance in health issues.
www.bensoc.asn.au

People with Acquired Brain Injury.
This site has information regarding Carer Resource Centres, locations of various services potentially required, and locations for respite. It is only available for some states of Australia.
www.infoxchange.net.au

Headway
Headway is an organisation based in the Illawarra in south New South Wales. The website provides details regarding the organisation's roles and provides contact details for further information.
www.headway.org.au

Brain Injury Association of U.S.A.
This is a comprehensive site that provides information on the brain, and treatment for head injury. It also has a section with downloadable booklets.
www.biausa.org

While you are waiting..
This is an excellent, comprehensive site from the USA for carers of brain injured people. It provides support through stories of those in similar situations. It also goes through detailed explanations of some treatments relevant to head injury.
www.waiting.com