Acquired brain injury: acute management

The aim of this article is to present a logical format for the care of patients with acquired brain injury in the high dependency and intensive care departments of district general hospitals. Acute and critical care are discussed with the expectation that the reader already has a knowledge base in these areas. This article may also be of value to nurses working in accident and emergency and other admissions units. After reading the article you should be able to:

I Describe acquired brain injury and identify the causes.
I Understand the basic structures and functions of the brain.
I Describe the investigations used in the diagnosis of brain injury.
I Undertake and give the rationale for using Glasgow Coma Scale and pupil reaction tests.
I Discuss the main aims of nursing care.
I Identify and prioritise patient care.
I Explain the importance of family support and collaborative care.

Acquired brain injury is a non-degenerative brain injury that has occurred since birth through some outside physical force or chemical derangement. The term 'acquired brain injury' includes all traumatic brain injury either open or closed, and non-traumatic injuries such as those caused by stroke and other vascular accidents, tumours, infectious diseases, hypoxia, metabolic disorders – including liver and kidney disease and diabetic coma – and by toxic substance taken into the body by inhalation, injection or ingestion (UK Acquired Brain Injury Forum 2000).

Acquired brain injury can occur at any time and to anybody. Most patients have had a full and often rewarding life before the injury and the subsequent effects can be devastating. Statistics show that this kind of injury affects more young people than old, with the majority of patients in long-term rehabilitation being young males.

Considering the national shortage of specialist beds, it is highly likely that many of these patients will be nursed in intensive and critical care units in general hospitals where specialist neurosurgical advice is not readily available. While many patients make a good recovery, they are often left with some kind of physical or cognitive deficit. Although hospital treatment cannot change the initial insult, good nursing and medical care will limit and prevent secondary damage thus reducing the probability of long-term disability.

The brain is an extremely delicate organ, which is protected by the hard outer covering of the skull or cranial bones. Underneath the skull the brain has three soft outer coverings or membranes called
The meninges (Figure 1):

- **Dura mater** – the outer layer of meninges, consisting of two layers of dense fibrous tissue. The outer layer takes the place of the periosteum on the inner surface of the skull and the inner layer provides a protective covering to the brain. A potential space exists between the two layers of the dura mater except at the formation of sinuses where venous blood drains between the layers of dura.

- **Arachnoid** – the middle membrane comprising a delicate serous membrane that is separated from the dura by the subdural space and from the pia mater by the subarachnoid space. The arachnoid mater passes over the convolutions of the brain created by the cerebrum. The subarachnoid space contains cerebrospinal fluid (CSF).

- **Pia mater** – the inner membrane of fine connective tissue containing minute blood vessels that completely cover each convolution and fissure in the brain.

In the brain are four irregular shaped cavities called ventricles that contain CSF (Figure 2). The CSF continuously circulates and bathes the brain and nervous tissue via the subarachnoid space, the ventricles and the spinal cord. It is a medium for the exchange of nutrients and provides protection against chemical and physical injury by acting as a shock absorber and maintaining an ideal environment for neuronal functioning. Oxygen and nutrients are supplied to the brain mainly by blood vessels that form the cerebral arterial circle at the base of the brain called the Circle of Willis (Figures 3 and 4).

The brain is divided into two hemispheres and is joined in the middle. The right hemisphere controls the left hand side of the body and vice versa. Each hemisphere is further divided into four lobes (Figure 5) and each lobe has specific functional areas (Figures 6 and 7 and Box 1).
intracranial pressure (ICP). This is represented in Figure 8. An increase in pressure in any of these three components will increase the ICP. Should this occur, blood and CSF will leave the cerebral circulation to maintain homeostasis. This is called autoregulation (Figure 9). However, as pressure in the brain rises, the brain is unable to regulate itself and the brain tissues become damaged due to a lack of blood supply and oxygenation (Hanley 1997). The brain requires a cerebral blood flow of at least 50-100ml at a perfusion pressure of 60mmHg to maintain optimal oxygenation (Alan 1986). When cerebral blood flow falls to levels below 30-100ml, the patient will begin to lose consciousness and may exhibit symptoms such as seizures (Germon et al 1994). Once pressures rise above a certain level, the only outlet is down the spinal column. This is known as coning and occurs when brain tissue begins to exit the brain enclosure through the foramen magnum and into the spinal column (Sharr 1984). This is a fatal condition (Hudak et al 1998).

Cerebral blood flow (CBF) and cerebral perfusion pressure (CPP – the pressure required to provide an adequate CBF) are directly related to mean arterial pressure (MAP) and ICP. The following equation represents this:

\[ \text{CPP} = \text{MAP} - \text{ICP} \]

The management of head injured patients should aim to maintain optimal pressures in the brain to prevent any secondary damage – primary damage being that which occurred at the initial injury (Matta and Menon 1997, Odell 1996). Secondary damage is primarily a result of hypoxia and for this reason management is aimed at maintaining adequate CPP.

<table>
<thead>
<tr>
<th>Body Area of control</th>
<th>Function</th>
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<tbody>
<tr>
<td>Basal nuclei</td>
<td>Skeletal muscle tone</td>
</tr>
<tr>
<td>Thalamus</td>
<td>Sensory input from skin, viscera and sense organs, which are then transmitted to the cerebrum</td>
</tr>
<tr>
<td>Hypothalamus</td>
<td>Output of hormones from the anterior pituitary and the autonomic nervous system, that is, thirst, hunger, body temperature, heart and blood vessels, flight or fight mechanisms</td>
</tr>
<tr>
<td>Midbrain</td>
<td>A relay station for ascending and descending nerve cells from the cerebrum and pons varolii</td>
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<tr>
<td>Pons varolii</td>
<td>Relay station for cranial nerves</td>
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<tr>
<td>Medulla</td>
<td>Autonomic reflex activity – the cardiac centre, respiratory centre, vasomotor centre, vomiting, coughing, oblongata sneezing and swallowing</td>
</tr>
<tr>
<td>Cerebellum</td>
<td>Co-ordination of voluntary muscular movement, posture, balance and equilibrium and proprioception occurring below the level of consciousness</td>
</tr>
<tr>
<td>Cerebral cortex</td>
<td>Memory, intelligence, thinking, conscience, learning, reasoning, morality, sensory perception and the initiation of voluntary muscle control (Ross and Wilson 1990)</td>
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Neurological observations allow nurses to make an initial assessment of the patient's health status. They also provide a baseline for comparison of further observations plus immediate evidence of any deterioration in the patient's condition. Observation of the neurologically impaired patient should provide information on five critical areas:

1. Level of consciousness.
2. Pupillary activity.
4. Sensory function.
5. Vital signs.

Monitoring the vital signs should, similar to any critically ill patient, include assessment of peripheral perfusion, arterial blood pressure – MAP should be documented separately – heart rate and rhythm, central venous pressure, temperature and respiratory rate.

**Figure 7. Somatotopic organisation of the cerebrum**

**Figure 8. Components of intracranial pressure**

**Figure 9. Autoregulation of the brain**

### Box 2. Glasgow Coma Scale

1. **Eye opening:**
   - Score 4: Spontaneously
   - Score 3: In response to voice
   - Score 2: In response to pain
   - Score 1: No response
   - C = eye closed or swollen

2. **Best verbal response:**
   - Score 5: Orientated
   - Score 4: Confused
   - Score 3: Inappropriate speech
   - Score 2: Incomprehensible speech
   - Score 1: No response
   - T = intubated or tracheostomy

3. **Best motor response:**
   - Score 6: Obey commands
   - Score 5: Localises to pain
   - Score 4: Flexes to pain
   - Score 3: Abnormal flexion
   - Score 2: Abnormal extension
   - Score 1: No response
   - S = sedated patient

Lowest possible score = 3
Highest possible score = 15

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**Identify the normal range for ICP and consider how the following activities contribute to raising the ICP:**

- Coughing
- Shouting
- Sneezing
- Shivering
- Defecating
- Exercise

You may wish to consult a textbook to assist you in this task.
The Glasgow Coma Scale (GCS) is a tool used to assess a patient's level of consciousness, which is important in monitoring the effects of head injury. Observations should be made of patients with acquired brain injury or other neurological disorders to assess their neurological status and encourage early identification of deterioration.

The GCS is based on three components:
1. Motor response
2. Verbal response
3. Eye opening

Each component is scored on a scale of 1 to 6, with 6 being the best score (full awareness) and 1 being the worst score (no response).

Guidelines being developed indicate that the GCS should be used to assess all brain-injured patients and that scores should be interpreted previously (Grant et al. 1995).

The regularity with which observations should be made of patients with acquired brain injury varies from hospital to hospital. In some hospitals, the GCS should be reviewed every hour, while in others it may be reviewed every three hours. The regularity with which observations should be made should be documented and agreed in the patient's nursing chart.

Documentation of observations should be thorough, allowing the nurse to notice changes immediately and ensure that the patient is monitored regularly, allowing the nurse to notice changes immediately.

The Glasgow Coma Scale (GCS) is significant and medical staff should be informed if a fall of two points in the GCS occurs. If the patient remains stable on hourly GCS for four hours, then it can be reduced to two-hourly for the remainder of the stay (NICE 2003).

The GCS is used to assess all brain-injured patients and should be used to assess all brain-injured patients. It is suggested that during the handover of shifts when nurses have been doing neurological observations, the neurological status and encourages early identification of deterioration.

Motor response

The patient's best motor response is scored using a series of tests. For example, the patient may have dysphasia from damage to the speech and cognitive centres situated in the frontal lobe of the brain that allows assessment of how the brain is functioning by obtaining specific information about the patient's neurological status. Impaired pupillary accommodation may prevent eye opening, such as bruising and swelling, pain or not occur at all. Some pre-existing conditions may be spontaneous, or occur in response to speech, pain, or injury. Pupil constriction and dilation is significant and medical staff should be informed if a fall of two points in the GCS occurs.

Verbal response

For example, the patient may be able to obey commands after squeezing someone's hand. Gripping the patient (Rush 1997). Care should be taken not to mark or bruise the patient and it is not permissible. Ethical considerations should be made when examining the presence of facial injuries (Ellis and Cavanagh 1992). The patient may have dysphasia from damage to the speech and cognitive centres situated in the frontal lobe of the brain that allows assessment of how the brain is functioning by obtaining specific information about the patient's neurological status.

Eye opening

This gives an indication of the patient's neurological status. Impaired pupillary accommodation may prevent eye opening, such as bruising and swelling, pain or not occur at all. Some pre-existing conditions may be spontaneous, or occur in response to speech, pain, or injury. Pupil constriction and dilation is significant and medical staff should be informed if a fall of two points in the GCS occurs.

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dilation is controlled by the third cranial nerve (the oculomotor nerve), which arises in the midbrain and runs through the centre of the brain. Pressure on this nerve will produce unequal or non-reacting large pupils. In the majority of cases both eyes work together, therefore a reaction seen in one eye should be identical in the other.

The essence and most important factor in any medical and nursing diagnosis is a detailed clinical history. Certain factors are of paramount importance in both treatment and prognosis (Box 5).

Obtaining images of the brain using various techniques gives clarity to specific regions and helps in obtaining an exact diagnosis. These techniques are listed in Box 6.

**Equipment needed:** pen torch

**Procedure**

Inform the patient that you are going to look into their eyes with a torch whether conscious or not and explain procedure.

**Rationale**

Sense of hearing may not be impaired. Aids in the reduction of anxiety. Ensures, as far as possible, that the patient consents to, and understands, the procedure.

**Procedure**

Darken the room if necessary.

**Rationale**

Enables better view of the eye and reaction to light stimulus.

**Procedure**

Wash hands.

**Rationale**

Prevents contamination of the eye with infection.

**Procedure**

Hold both eyes open and note size, shape and equality of the pupils.

**Rationale**

To assess the size, shape and equality of the pupils as an indication of brain damage.

Normal pupils are spherical, usually central and range in diameter from 1.5-6.0mm.

**Procedure**

Hold one eye open, moving the light shining from the pen torch towards and across the eye from the side. This should cause the eye to constrict quickly.

**Rationale**

To assess pupil reaction to light. A normal reaction indicates no lesion or pressure on the third cranial nerve or brain-stem regulating pupil reaction.

**Procedure**

Hold both eyelids open, shining the light in the same manner into the same eye. The pupil into which the light is NOT shone should also constrict equally.

**Rationale**

To assess consensual light reflex. Prompt, equal constriction in the opposite eye indicates intact connections between areas that control constriction.

**Procedure**

Record unusual eye movements.

**Rationale**

To assess cranial nerve damage.

**Procedure**

Repeat tests on the opposite eye.

**Rationale**

To assess equality of reaction and ensure all areas are functioning correctly. Differing reactions indicate damage to the side of the brain that controls the eye being tested. The left side of the brain controls the left eye and the right side controls the right eye. (Mallet and Pritchard 1992)

**Box 3. Guidelines for pupil reaction test**

**Box 4. Suggested answer to Time Out 4**

**TIME OUT 4**

Jane is in her late 20s. She was found unconscious in the street and brought into A&E by the police. She has since regained a level of consciousness, but is unable to give a coherent history. Some bruising and swelling are evident around her right eye and temple. Having been stable for some hours with a GCS of 13, Jane suddenly becomes unresponsive to verbal stimulation and her breathing has become slow and obviously laboured. There is an audible snoring on inspiration and she begins to vomit. What would your first considerations be and what further observations would you make? See Box 4 for suggested answer.

When considering Time Out 4 you should have identified that the immediate action would be to maintain a patent airway as there is a risk of aspiration through vomiting, and that the condition has changed and therefore pupil reaction and GCS should be reassessed.

**Box 5. Clinical factors**

**I** The patient's age

**I** Mode of onset

**I** Duration of symptoms

**I** Family history

**I** Previous medical history

(Jones and Tomson 1998)
Much of the nurse’s role in caring for brain-injured patients is concerned with monitoring and observation. Nurses have become expert in the early recognition of illness, yet this is an area of knowledge often overlooked in the quest to learn new techniques (Benner 1984). Benner identifies the role of administering and monitoring therapeutic regimens as a key area of nursing practice. It is vital that the nurse is able to identify changes in the patient’s condition and knows the appropriate steps to take if the condition deteriorates. It is therefore important that the nurse understands the aims of managing brain-injured patients in the critical care environment, which are to prevent or reduce the risk of secondary injury occurring (that is, any injury subsequent to the primary injury, such as hypoxia or bleeding).

Ventilation and oxygenation

Oxygen saturation should be monitored continually using pulse oximetry, and oxygen therapy should be administered as appropriate to maintain saturations above 98 per cent (Hall 1997). A patient who is maintaining an airway and breathing spontaneously is in a potentially dangerous position because conditions can change rapidly. Respiratory rate, depth and rhythm should be noted and any changes reported. Decreasing levels of consciousness may prevent adequate airway maintenance and increase the risk of aspiration. Noisy, snoring and harsh breath sounds may be a sign that the airway is

Nursing and clinical interventions

Tool Method

Computed tomography (CT) scan This is the use of a computer to take pictures of slices of the brain. X-rays are fired at different angles of the brain and picked up by receivers. The images obtained are analysed by the computer producing a series of pictures through the skull and brain. Dye (contrast) may be injected into a vein to highlight areas when more information is required. This method is useful in demonstrating the presence of tumours, cerebrovascular accident and bleeding. It is a painless procedure, requiring the patient to lie in the scanner, with the head extremely still. Therefore, the patient needs to be co-operative or otherwise sedated.

Magnetic resonance imaging (MRI) A large, powerful magnet circles the patient’s skull. Atoms in the brain orientate themselves around the magnetic field. Radio waves are then fired at the patient causing hydrogen atoms to resonate. As the atoms return to a resting state they give off radio waves that are picked up by receivers and analysed by a computer giving a detailed picture of the brain. This technique can detect subtle changes and abnormalities in the brain which are undetectable by CT scan.

Angiography This method of investigation is used in the diagnosis and treatment of aneurysms. A dye is injected into a vein and radiography tracks its progress through the intricate mesh of arteries in the brain. Abnormal arteries are easily highlighted on X-ray.

Electroencephalography (EEG) This is a recording of the electrical impulses occurring in the brain. Similar to ECG monitoring of the heart, the patient has electrodes placed around the skull that amplify and magnify the tiny electrical impulses from the brain and record them onto paper in seconds of time. It is a harmless and painless investigation and is useful in the diagnosis of epilepsy and in monitoring deeply comatose patients. A normal pattern will show a waveform every tenth of a second. This slows down during sleep and speeds up when the patient is awake and alert. EEG monitoring can be performed by telemetry.

(Walker and Shorvon 1996)
Dextrose solutions are not recommended because pressure is more stable in well hydrated patients. These fluids have the same osmolarity as plasma. Venous therapy in brain-injured patients because changes should be identified and reported (NMC 2002a). The findings should be documented and any venous pressure are the best indicators of fluid status.

Oral mucosa, blood pressure, pulse and central skin turgor, peripheral temperature, capillary refill, should be monitored closely and the patient's ability to cough and swallow assessed. Intravenous therapy may be necessary until full diet and nutrition is restored. Many sedative drugs cause dramatic vasodilation and therefore hypotension. This is best avoided by the use of inotropes. Nurses should be acting by the use of inotropes. Nurses should be aware of the NMC (2002b) guidelines This requires close patient monitoring and care.

Cardiovascular status of blood oxygen and carbon dioxide. Practice recommends maintaining normal values ischaemia and cell death (Iacono 2000). Current practice is aimed at providing adequate hydration with an equal balance achieved. Current management is aimed at preventing severe hypoxaemia, constricting cerebral vessels thus reducing blood supply to the brain (Gerraci and Gerraci 1996). However, it is recognised sedation score (Beggan 1994). Hourly measurement of urine output may be prolonged. The drug of choice for sedation should have a short half-life so it is eliminated the early.
It is important to monitor and maintain body temperature as hypothermia can reduce mortality and permanent disablement by up to 60 per cent in the brain-injured patients. The use of a head-up tilt of 30º to allow cerebral drainage and prevent respiratory complications is recommended.

The care of patients with acquired brain injury must be individualised to meet the needs of the individual patient. Research recommendations for an improved service for patients include the development of care pathways and joint collaboration with community-based groups involved in long-term rehabilitation.

Patient positioning is an important aspect of nursing practice and can dramatically improve ICP control. Correct positioning for each stage of brain-injured patients is critical. Research recommends that head-injured patients should be positioned with the head elevated to a head-up tilt of 30º to allow cerebral drainage and prevent respiratory complications. Placement of the head-up tilt helps to meet the needs of the individual patient.

While these recommendations are specific to brain-injured patients, they may also apply to other complications that require alternative interventions when the patient is well sedated.

Correct positioning for each stage of brain-injured patients is an important aspect of nursing practice and can dramatically improve ICP control. Proper positioning helps to meet the needs of the individual patient.

Conclusions

- The care of patients with acquired brain injury must be individualised to meet the needs of the individual patient.
- Research recommendations for an improved service for patients include the development of care pathways and joint collaboration with community-based groups involved in long-term rehabilitation.
- Correct positioning for each stage of brain-injured patients is critical. Research recommends that head-injured patients should be positioned with the head elevated to a head-up tilt of 30º to allow cerebral drainage and prevent respiratory complications.
- Proper positioning helps to meet the needs of the individual patient.

References
