

Preoperative assessment of neurosurgical patients

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Abstract

The aims of the preoperative assessment of neurosurgical patients include exchange of information, reassuring the anxious patient, establishing whether raised intracranial pressure is present and optimizing any co-existing medical problems, which may or may not be related to the neurological condition. The patient's neurological status must be assessed and documented preoperatively as it will impact on the anaesthetic and is vital for assessing the patient in the postoperative period. Patients often have co-morbidity and are commonly taking hypoglycaemic, anticonvulsant, anticoagulant, antihypertensive, corticosteroid, and chronic pain medication, all of which may influence the conduct of anaesthesia. Fluid and electrolyte disturbances are common as a result of the underlying condition or of the treatment received. It is important that these are identified and corrected preoperatively. Difficult airways are encountered frequently (e.g. in patients with cervical spine abnormalities or acromegaly) and it is therefore particularly important to carry out a detailed airway assessment and construct a plan for airway management. The preoperative assessment and consideration of the underlying neuropathology allow formulation of an appropriate and safe plan for induction, airway management, maintenance of anaesthesia and postoperative care.

Keywords Glasgow Coma Score; intracranial pressure; neurosurgical patients; preoperative assessment

General anaesthetic history

The pre-assessment of neurosurgical patients not only allows anaesthetists to assess the history and preoperative condition of the patient but also provides an opportunity to reassure an anxious patient. The Association of Anaesthetists has recently published anaesthetic pre-assessment guidelines.¹ In addition, it presents the opportunity for preoperative drug prescribing,

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Learning objectives

After reading this article, you should be able to:

- identify the signs and symptoms of increased ICP preoperatively
- identify the common electrolyte abnormalities associated with neurosurgical patients
- assess the anaesthetic risks associated with the proposed surgery and plan the appropriate postoperative care for these patients.

planning the conduct of anaesthesia and invasive intraoperative monitoring, as well as planning of the most appropriate destination for the patient postoperatively. Thus patients undergoing complex cranial surgery will require postoperative nursing in a high-dependency area whereas those undergoing uncomplicated spinal surgery often return to the general ward.

In common with all surgery, it is important to take a full general anaesthetic history, with an emphasis on the particular areas outlined below.

Neurological status

An assessment of a patient's neurological status by the anaesthetist is vital. The Glasgow Coma Score (GCS) is an integral part of this assessment and should be documented preoperatively in all patients. It allows assessment of the patient's level of consciousness and gives an indication of the urgency of surgery as well as being a useful tool in comparing the patient's gross neurological condition at different time points.² The GCS should be documented as a breakdown of the three modalities assessed (e.g. best eye response 2; best verbal response 2; best motor response 4; rather than simply GCS 8) as this gives more information on the patient's condition. A GCS of 8 or lower indicates a conscious level that may result in significant risk of hypoxaemia and hypercarbia, both of which may cause an increase in intracranial pressure (ICP). To preserve cerebral perfusion and protect the airway these patients should undergo early tracheal intubation and mechanical ventilation. A rapidly decreasing GCS suggests progression of the underlying condition, or a new cerebral event, warranting urgent investigation and management. Pupil size and reaction should also be documented – this becomes particularly important in a patient with increased ICP, who is due to have or has had anaesthesia.

Most patients presenting for urgent or elective surgery will have a normal GCS. However, it is important to note and document any pre-existing sensory and motor deficits and more subtle symptoms and signs of raised ICP (Box 1). Radiological images should be carefully examined for signs of raised ICP and to characterize the lesion responsible (Box 2).

The anaesthetist should also document any bulbar, respiratory, motor or autonomic dysfunction.

Fluid and electrolyte disturbances

Patients presenting for neurosurgery are at particular risk of developing fluid and electrolyte disturbances for many reasons.

Signs and symptoms of raised intracranial pressure

- Headache – postural, worse in morning or on coughing, sneezing
- Vomiting
- Papilloedema
- Unilateral/bilateral pupillary dilatation
- Cranial nerve II or VI palsy
- Drowsiness/loss of consciousness
- Absent brainstem reflexes
- Arterial hypertension
- Bradycardia
- Abnormal respiration

Box 1

A decreased conscious level, vomiting, bulbar dysfunction or pending surgery often results in poor oral intake, leading to dehydration. Subsequent overzealous intravenous rehydration may cause fluid overload and electrolyte imbalance. Furthermore, the patient may have received osmotic or loop diuretic therapy as part of the management of raised ICP. The neurological pathology itself can also be associated with disturbances of sodium/water balance (i.e. syndrome of inappropriate anti-diuretic hormone secretion (SIADH), cerebral salt wasting (CSWS) and diabetes insipidus) (Table 1).

Hyperglycaemia is a commonly encountered problem among neurosurgical patients, either due to corticosteroid treatment or as a result of brain injury. This exacerbates secondary ischaemic injury and worsens neurological outcome by several mechanisms including hyperosmolality, lactic acidosis, alterations in neuronal pH and increases in excitatory amino acids. All the benefits of tight glycaemic control are being questioned in general intensive care patients, the incorporation of glycaemic control (5.5–9 mmol/litre) is an important component of head injury management and this often requires intravenous insulin during the perioperative period.

Drug therapy

Patients presenting for neurosurgery are commonly receiving corticosteroid, antihypertensive, and anticonvulsant drugs as

Radiological signs indicating raised intracranial pressure

Computed tomography/magnetic resonance imaging scans

- Mass
- Hydrocephalus
- Cerebral oedema
- Midline shift
- Obliteration of cerebrospinal fluid cisterns around brainstem
- Effacement of ventricles and cortical sulci

Box 2

well as aspirin and other anti-platelet drugs, warfarin, analgesic and antiglycaemic drugs.

Most of these drugs should be continued into the perioperative period. However, anticoagulants such as warfarin and clopidogrel should be stopped at the appropriate time to allow clotting and platelet function to return to normal. Aspirin is also often stopped, but the decision to do so requires consideration of the risks and benefits and should involve the anaesthetist, surgeon and cardiologist.

Chronic pain therapy should generally be continued perioperatively allowing better control of postoperative pain.

Patients with diabetes usually have their oral hypoglycaemic drugs omitted on the morning of surgery and, unless undergoing a short minor procedure, should receive an insulin sliding scale to optimize glycaemic control in the perioperative period. Patients taking corticosteroids should have their blood glucose measured regularly.

Antihypertensive agents, with the exception of angiotensin-converting enzyme inhibitors and angiotensin II receptor antagonists which may cause refractory hypotension intraoperatively, should be continued throughout the perioperative period.

Similarly, it is essential that anticonvulsant agents are continued perioperatively whilst remembering that they can cause induction of hepatic enzymes and thus influence the pharmacokinetics of many anaesthetic drugs.

Airway

Certain groups of neurosurgical patients can present an anaesthetist with airway difficulties and it is vital that these difficulties are recognized and documented preoperatively. These groups of patients include those with cervical spine disease or instability, patients wearing a cervical collar and patients with acromegaly. If a fiberoptic tracheal intubation, either awake or under sedation, is planned, a full explanation should be given to the patient and the use of an anticholinergic premedication considered and prescribed accordingly.

Co-existing disease

Co-morbidity is common in the neurosurgical population. Hypertension is a risk factor for, and associated with carotid artery stenosis and cerebral aneurysms, and so is frequently encountered in this population of surgical patients. Chronic hypertension causes a right shift of the cerebral autoregulation curve and therefore episodes of hypotension are more likely to cause cerebral hypoperfusion. Blood pressure should be controlled perioperatively where possible; furthermore, if intraoperatively controlled hypotension is to be used, accepted limits must be adjusted accordingly.

Diabetes, ischaemic heart disease and epilepsy are also commonly encountered in neurosurgical patients. All co-existing medical problems should be assessed, investigated appropriately and optimized preoperatively.

Premedication

Sedative premedication should be avoided in patients with a reduced GCS or raised ICP. They may further obtund a patient, and respiratory depression can cause an increase in arterial carbon dioxide tension sufficient to further increase ICP and adversely affect cerebral perfusion. In addition, early

Fluid and electrolyte disorders associated with neurological pathology

Condition	Serum sodium concentration	Plasma volume	Serum osmolality	Urine sodium concentration	Urine osmolality	Treatment
SIADH	Low	Normal or increased	Low	High	High	Fluid restriction
CSWS	Low	Decreased	Normal or high	High	Normal or high	Isotonic or hypertonic saline
DI	High	Decreased	High	Normal	Low	Hypotonic saline + vasopressin

CSWS, cerebral salt wasting; DI, diabetes insipidus; SIADH, syndrome of inappropriate antidiuretic hormone secretion.

Table 1

postoperative assessment of the patient's neurological status may be impaired by sedative premedication.

Patients undergoing posterior fossa surgery have a high incidence of postoperative nausea and vomiting and may benefit from preoperative anti-emetic medication. As mentioned earlier, an antisialogogue could be prescribed if an awake fiberoptic intubation is planned.

An H₂-receptor antagonist or proton-pump inhibitor should be considered for patients at risk of aspiration of gastric contents.

Commonly encountered disorders

Certain conditions and surgical procedures are encountered regularly with neurosurgical patients and require specific enquiries and investigations. These are reviewed below.

Epilepsy

Details concerning patient history, the duration of epilepsy, seizure nature, frequency and pattern, current anticonvulsant therapy (including plasma levels) and complications of current and past anticonvulsant therapy should be documented.

Co-existing medical problems are common and these should be established and treated if possible. The mental state of the patient should be assessed and recorded before induction of anaesthesia to assist anaesthetic and recovery staff with postoperative patient assessment.

Patients with refractory epilepsy presenting for hemispherectomies will often have severe learning difficulties, and therefore their ability to comprehend and cooperate may be limited.

Anticonvulsant therapy must be continued throughout the perioperative period and this may involve conversion to a parenteral formulation. Recent plasma concentrations of anticonvulsants should be available where possible to ensure they lie within the therapeutic range. Benzodiazepine premedication should not be given if inter-ictal spike activity is being recorded during surgery.

Movement disorders

Patients with movement disorders (e.g. Parkinson's disease, dystonia, Tourette's syndrome) may present for deep-brain stimulator insertion. If the patient is able to cooperate, the procedure is performed under local anaesthesia and it is therefore vital to carefully assess whether their symptoms would preclude such a technique.

The presence of autonomic neuropathy is not uncommon in this population of patients and an anaesthetist must elicit symptoms or signs of postural hypotension or dysrhythmias. The Valsalva manoeuvre is a simple test that can be performed at the bedside.

Bulbar function may also be poor, and a history of dysphagia or recurrent chest infections should be established. The patient's cough should be assessed and evidence of retained secretions sought. If there is a history of gastro-oesophageal reflux, a proton-pump inhibitor or H₂-receptor antagonist should be prescribed. In addition the patient's nutritional state needs to be assessed, as this may need to be addressed preoperatively, as well as postoperatively.

A careful drug history should be taken and this should include details of the timing of doses. Medications should continue as normal or, in the case of patients with Parkinson's disease undergoing long procedures, changed to a subcutaneous apomorphine infusion.

If respiratory symptoms or signs are present a chest radiograph should be performed and an arterial blood-gas analysis and spirometry may be useful if restrictive/obstructive lung disease or motor neuropathies are suspected.

Head injury

More than one million people per year in the UK present to hospital with a head injury. Most of these people are young, and 10–40% have associated intra-abdominal and bony injuries.

Surgical treatment is usually required for elevation of depressed skull fractures, evacuation of extradural, subdural and intracerebral haematomas, and for decompressive craniotomy to reduce refractory intracranial hypertension.

The primary aim of head injury management is to prevent secondary brain injury. The preoperative assessment and initial management of the patient often go hand in hand, depending on the severity of the injury. The initial assessment and management follow the current Advanced Trauma Life Support guidelines. Associated injuries should be identified and managed accordingly.

Priorities are ensuring adequate oxygenation and maintaining a normal cerebral perfusion pressure (CPP). If there are any concerns about airway safety or if oxygenation is inadequate, the patient should be intubated and mechanically ventilated immediately. The GCS should be documented before tracheal intubation if possible. Arterial blood pressure must be maintained at

a level that ensures an adequate CPP (i.e. if ICP is high, mean arterial pressure needs to be elevated).

All patients with a head injury should be assumed to have a cervical spine injury until cleared radiographically, and therefore in-line stabilization must be maintained during tracheal intubation.

It is vital to look for evidence of pulmonary contusions, fat emboli and neurogenic pulmonary oedema before embarking on anaesthesia. Sedative premedication must be avoided.

Common neurosurgical procedures

Craniotomy

Intracranial masses may be congenital, neoplastic, infectious or vascular. The presentation will depend on the location and growth rate of the lesion and ICP. Common symptoms include headache, seizures, focal neurological deficits or cognitive decline. Generally, craniotomies can be divided into supratentorial or infratentorial (i.e. posterior fossa).

Supratentorial craniotomy: supratentorial lesions typically present with seizures, motor and sensory dysfunction or impairment of speech. An initial assessment of the patient's neurological and mental state will establish whether the remainder of the history from the patient is reliable. A history should be taken from relatives when necessary. Any pre-existing confusion or neurological deficit should be documented.

During the preoperative visit it is important to establish whether the patient is suffering from raised ICP. Although a decreased level of consciousness (and therefore GCS) is a common sign of severely raised ICP (usually >40 mmHg), more subtle increases are associated with nausea, vomiting and visual disturbance due to papilloedema. Critically raised ICP causes hypertension, bradycardia and respiratory irregularities (Cushing's triad). Other signs and symptoms of raised ICP are listed in [Box 1](#). These include pupillary dilatation due to compression of the third cranial nerve and gaze palsy due to fourth or sixth nerve involvement.

Examination of radiological images is particularly important, looking for signs of raised ICP (evidence of brain oedema, midline shift (>0.5 cm), ventricular size, appearance of sulci and grey/white differentiation). It is also important for gathering information about lesion size, surgical access and patient positioning. If a metastatic lesion is suspected, other radiological investigations may be indicated (e.g. chest radiograph).

The patient's medication (including corticosteroid, diuretic and anticonvulsant therapy) should be carefully reviewed. These drugs are usually continued throughout the perioperative period.

In addition to the routine preoperative blood tests, anticonvulsant drug levels should be determined if appropriate. Particular attention should be directed to serum electrolyte levels because disturbance of electrolyte balance, especially sodium balance, is common in patients presenting for neurosurgery. Premedication should be avoided.

Infratentorial craniotomy: posterior fossa surgery is usually indicated for the excision of tumours or vascular lesions. Symptoms of posterior fossa masses are the result of damage to local structures, including cranial nerves and their nuclei and

cerebellar structures. They include hearing loss, visual field defects, eye movement problems, pupillary disorders, facial muscle weakness, taste disturbances, loss of facial sensation, bulbar weakness and unsteady gait.

Posterior fossa lesions frequently obstruct cerebrospinal fluid flow by compressing the fourth ventricle or by obstructing the cerebral aqueduct; many patients therefore present with obstructive hydrocephalus.

Again, it is vital to document neurological status before surgery. Cranial nerve examination is mandatory and a thorough assessment of bulbar function is especially important. Many patients with swallowing difficulties will be dehydrated and require adequate preoperative fluid resuscitation and electrolyte correction. In addition, poor bulbar function predisposes to aspiration of both saliva and gastric contents, and recurrent chest infections are a common occurrence in this group of patients. The patient should be warned that a nasogastric tube will be in place postoperatively and there may be prolonged postoperative mechanical ventilation. On occasions, bulbar function may be so impaired that a tracheostomy and percutaneous endoscopic gastrostomy may be necessary.

Radiological images should be studied carefully before the anaesthetic is administered. It is especially important to determine whether midbrain compression is present because this may be associated with cardiovascular instability during surgery; the presence of hydrocephalus and cerebral oedema should also be noted. Patients with significant hydrocephalus often undergo a shunting procedure before the definitive surgery.

Posterior fossa surgery is performed with the patient in one of three positions – prone, lateral or sitting. Although the sitting position is becoming less used in adult neurosurgical practice, it affords excellent operating conditions for the surgeon. The major complication of the sitting position is venous air embolus. This is further complicated if the patient has a patent foramen ovale as air enters the arterial system. Although this patency is usually silent in most individuals, it is important to listen carefully for murmurs that might suggest atrial or ventricular septal defects, and if one is suspected then a cardiac echo is required to rule out the presence of an intra-cardiac shunt.

Patients undergoing posterior fossa surgery have a high incidence of postoperative nausea and vomiting, and preoperative anti-emetic medication should be considered.

Awake craniotomy: awake craniotomy is indicated for movement disorder surgery, epilepsy surgery and surgical resection of lesions in the eloquent (functional) cortex. Appropriate patient selection is critical for the success of the procedure. In addition to the routine preoperative considerations, a number of issues are important. During the procedure, the patient's head is usually 'clamped' in a fixed position, often for many hours. Sedation is given during the craniotomy stage and as the patient is intubated, the airway is potentially at risk; therefore, the technique should not be used on patients with complicated airway problems. Furthermore, the patient has to be able and willing to cooperate in lying still for long periods. A very careful explanation of the procedure is essential. In addition patients may require a neuro-psychiatric assessment, as well as a detailed speech and language test, to rule this out as a cause of any intra-operative decline in speech.

Neurovascular surgery: neurovascular surgery is carried out for the treatment of ruptured and unruptured aneurysms, arteriovenous malformations (AVM), and carotid artery stenosis. All of these conditions may be treated by conventional surgical methods or, increasingly, by radiological intervention. Whichever method is chosen, careful preoperative assessment of the patient is essential. This assessment should be directed towards the identification of associated risk factors such as hypertension, smoking and polycystic kidney disease and of any other resultant end-organ disease.

Ruptured cerebral aneurysm: ruptured cerebral aneurysm results in subarachnoid haemorrhage (SAH). In the 50% of patients who survive the initial haemorrhage, management is directed at clipping or coiling the aneurysm to prevent a further bleed. Preoperative assessment must establish the severity of the SAH; the Hunt and Hess³ (Table 2) and the World Federation of Neurological Surgeons⁴ (Table 3) scales are the most commonly used grading systems. The preoperative visit must also establish whether the common complications of SAH are present (e.g. hydrocephalus, seizures and vasospasm). Clinical vasospasm occurs 3–14 days following SAH in up to 40% of patients, but can occur up to day 21. In an attempt to prevent vasospasm, patients are often treated with the cerebral selective calcium-channel blocking drug nimodipine. If vasospasm has developed, the patient will be treated with triple H therapy (i.e. hypertension, hypervolaemia and haemodilution) to promote flow through the narrowed cerebral arteries. Vasopressor therapy may also be indicated.

Patients who have suffered an SAH often have respiratory complications, including pneumonia, pulmonary oedema or pulmonary embolus and it is important to detect and manage these appropriately.

Cardiac dysfunction is frequently associated with SAH and patients may present with hypertension, arrhythmias or pulmonary oedema. Ventricular wall dysfunction is present in 30% of patients and diffuse myocardial ischaemia occurs in

The Hunt and Hess subarachnoid haemorrhage scale

Grade	Symptoms/signs	Prognosis (approximate survival)
1	Asymptomatic or mild headache/nuchal rigidity	70%
2	More severe headache. No neurological deficit other than cranial nerve palsy	60%
3	Drowsiness or confusion ± mild focal neurological deficit	50%
4	Markedly impaired consciousness with moderate or severe neurological deficit	20%
5	Deep coma, decerebrate rigidity, moribund	10%

Table 2

World Federation of Neurological Surgeons (WFNS) subarachnoid haemorrhage scale

Grade	Glasgow Coma Scale	Motor deficit
1	15	Absent
2	14–13	Absent
3	14–13	Present
4	12–7	Present or absent
5	6–3	Present or absent

Table 3

approximately 50%. Following a careful history and examination, the patient should have an electrocardiograph and cardiac enzymes determination; further investigations such as an echocardiogram and thallium scan may be indicated if myocardial injury is suspected. Cardiac function should be optimized preoperatively.

Sodium balance is often deranged following SAH and may be due to overzealous fluid resuscitation, SIADH or CSWS. Correction should be carried out before anaesthesia and surgery.

Unruptured cerebral aneurysm: unruptured cerebral aneurysm may be treated with surgical clipping or with embolization using coils or glue. Patients undergoing craniotomy for surgical treatment should have the routine preoperative assessment and management. Blood should be cross-matched for the procedure. Similar considerations apply to radiological treatment of aneurysms because surgical intervention may be necessary if the embolization fails.

High-dependency care is indicated for all patients undergoing elective or emergency aneurysm surgery or embolization.

Carotid artery surgery: carotid artery surgery procedures to increase the diameter of atherosclerotic carotid arteries include surgical endarterectomy and stenting of the vessel using interventional radiological techniques. Both procedures can be carried out under regional or general anaesthesia.

Most patients presenting with carotid artery disease have co-existing disease, including diabetes and hypertension. Coronary and renal vessels are invariably affected by the same atherosclerotic process and care must be taken in assessing and optimizing cardiac and renal function preoperatively. Many patients are smokers and pulmonary function may be impaired, a chest radiograph, lung-function tests and arterial blood–gas analysis are often indicated. In addition, these patients are usually taking aspirin and other anti-platelet drugs, and whether to continue the medication in the perioperative period must be carefully considered.

Pituitary surgery: approximately 40% of pituitary adenomas are endocrinologically silent and present with local mass effects (for example optic or other nerve palsies or pituitary hypofunction from gland destruction). However, most pituitary adenomas present with endocrine abnormalities secondary to hormone hypersecretion (i.e. acromegaly (growth hormone), Cushing's disease (adrenocorticotrophic hormone, ACTH) or infertility (prolactin)).

The preoperative assessment of a patient presenting for pituitary surgery should include an assessment of visual function, signs and symptoms of raised ICP and the effects of hormonal over- or under-secretion.⁵ Assessment of the patient's endocrine function will determine whether hormone replacement is required before surgery.

Acromegaly: acromegaly results from excess growth hormone secretion in adulthood and causes an overgrowth of bony and soft tissues. Co-morbidity, particularly diabetes mellitus, hypertension and coronary artery disease, is common. Patients can also develop cardiomyopathy. Any co-existing condition should be optimized preoperatively.

The airway may be dramatically involved in acromegaly with enlargement of the jaw, tongue and larynx from abnormal deposition of connective tissue. This may result in difficulties with tracheal intubation and awake fiberoptic techniques may be indicated. In severe disease, tracheostomy may be necessary. In addition, patients with acromegaly have a high incidence of obstructive sleep apnoea. Treatment with nasal continuous positive airway pressure is not possible following trans-sphenoidal pituitary surgery, and careful observation of the patient on a high-dependency unit is important.

Cushing's disease: ACTH-secreting pituitary tumours cause secondary adrenal hyperplasia, which subsequently leads to the features of Cushing's disease. Physical features include truncal

obesity, a moon face, skin atrophy, abdominal striae, and poor wound healing. Hypertension, diabetes, hypernatraemia, and hypokalaemia are also common and need to be carefully managed preoperatively. ◆

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