

Preoperative Evaluation - Neurosurgery

The Patient

General Considerations

Detailed preoperative knowledge of the patient's neurological disease and its pathophysiological effects as well as the usual assessment of their general medical state is essential to the proper planning of a neurosurgical anaesthetic. The purpose of the preoperative evaluation is to allow this assessment to occur, to inform the patient of the risks and options for their anaesthetic management and to formulate in conjunction with the surgeon an appropriate anaesthetic management plan.

For a general dissertation on Preoperative Evaluation the reader is referred to Roizen's Chapter in Miller's 4th edition.

Neurological History

The neurological history gives us valuable information about the patient's disease process and their current neurological state. The history is usually taken in a narrative fashion however if not volunteered one needs to ask specifically about:

Symptoms and duration

Where patient can't give a history, eg Trauma, Collapse

In these circumstances the patient is often unable to provide information and it is important to gather what information one can from witnesses to the injury/collapse or the paramedics who were involved in the resuscitation and transport. In many hospitals the Anaesthesia staff are not part of the trauma team and if this is the case then one should try and get information from the Emergency Room staff involved in the initial resuscitation.

The key pieces of information that must be obtained are:

Nature of the Trauma, eg MVA, Gun shot, etc

This gives valuable information about the likelihood of other injuries and the probable progression of their state.

Level of Consciousness

Immediately after the injury and whether this has changed since then.

Gross movement of limbs

A history of all limbs moving indicates no gross spinal injury, failure of leg movement raises the issue of paraplegia and no movement in one arm the possibility of brachial plexus injury (and possible first rib fracture and thoracic aortic damage).

Cardiorespiratory state since injury

Presence of hypo- or hypertension, hypoventilation, hypoxaemia

Where the patient can give a history

Seizures

This is often the mode of presentation for tumours. One needs to find out whether these are generalised or focal, whether anticonvulsant treatment has been started and whether or not it has been effective in controlling the seizures.

Focal signs

A history of neurological changes related to the location of the tumour is the other most common mode of presentation for tumours. The specific presentation depends on the location of the tumour. Supratentorial tumours involving the motor cortex may present with arm, face or leg weakness. Brainstem lesions may present with cranial nerve palsies.

Chronic subdurals may present with hemiparesis or arm weakness due to local pressure effects in addition to headaches and decreased mentation.

Rarely aneurysms, eg basilar aneurysms may present with cranial nerve palsies when they become large enough to produce local pressure effects.

The specific history will give clues as to the location of the lesion.

Symptoms/Signs of raised ICP

These are relatively nonspecific and depend greatly on the cause and rapidity of onset of the underlying pathology. The symptoms are either the result of compromised cerebral perfusion pressure (CPP) or from the effects of brain shift. If the effect is solely due to compromised CPP, eg as in Benign Intracranial Hypertension then the ICP will need to be as high as 40-50 mmHg before marked symptoms occur. If the pressure rise is non-uniform, eg trauma, tumours then brain shift will occur producing symptoms and signs related to herniation of brain tissue (see later). In these cases symptoms and signs may occur when the ICP is only 20-30 mmHg.

General symptoms of raised ICP include headache (classically worse in the morning and made worse by coughing and straining), nausea, vomiting, altered mentation and visual problems (III and VI nerve palsies).

Signs of meningeal irritation

Headache, photophobia and stiff neck are the classical symptoms and signs of this. Meningitis and subarachnoid haemorrhage (SAH) are the two most important causes.

Patients with SAH will often give a history episodes of transient symptoms 2-3 weeks preceding their final presentation. These are thought to represent minor haemorrhages (sentinel bleeding). Recognition of the importance of these symptoms prior to the final SAH can lead to diagnosis and treatment of the aneurysm with excellent outcome.

Peripheral Nervous System

A history of weakness of arms and or legs and loss of sensation should be sort. The exact level of these helps to determine the location of the lesion.

Bladder dysfunction indicates sacral nerve root dysfunction.

Transient Ischemic Attack (TIA)/Reversible Ischemic Neurological Deficits (RIND)

A TIA lasts from several minutes up to 24 hours, if the deficit last longer than this but resolves within 72 hours then it is called a RIND. If the deficit lasts longer than this it is called a stroke.

Carotid disease produces symptoms by two mechanisms, either embolic phenomenon (most common) or by hemodynamic insufficiency. In the later case the symptoms will occur when the blood pressure (BP) falls below some critical level. Symptoms on rising from a lying or sitting position is suggestive of this. If the patient has been admitted to hospital with TIAs and heparinised the BP at the time of subsequent TIAs (if lower than usual) is helpful in determining the lower limit for BP during their anaesthetic.

Knowing the type of TIAs helps determine the vascular area most at risk. Amaurosis Fugax (transient monocular blindness) is caused by platelet emboli to the ophthalmic arteries and is indicative of ipsilateral carotid disease. Transient weakness of the face and arm (often associated with difficulty speaking) indicates ischemia of the contralateral middle cerebral artery. Leg weakness (less common) indicated ischemia of the contralateral anterior cerebral artery. Posterior circulation (basilar/vertebral arteries) TIAs cause more nebulous symptoms of dizziness and vertigo, numbness of the contralateral face/limbs, diplopia, hoarseness, dysarthria and dysphagia. Hemiparesis is rare.

Stroke

Past cerebrovascular accidents must fully elucidated including when they occurred, their management and how they have resolved.

Interventions to date

Surgery/Anesthesia

The patients past history of Surgery and Anesthesia give vital information about the patients management in this case. If at all possible one should review the patients past operative and anesthetic records. Specific problems raised by the patient need to be discussed in full. If necessary one should contact prior anesthesiologists and surgeons to fully elucidate the nature of previous problems.

Patients who have hydrocephalus, especially those presenting as neonates, eg spina bifida, meningitis usually have a long and detailed surgical history of repeat shunt revisions and associated operations, eg Arnold Chiari malformation repairs, spinal surgery, temporal decompressions. These patients often have a very clear idea of what problems they have had with anesthetics and how they wish their anesthetic to be conducted.

Radiation

Local irradiation has little anesthetic importance however if the patient is presenting with a metastases and has had radiation to the primary site then the effects there need to be considered. Occasionally a patient who has irradiation for spinal metastases may develop acute cord compression and need an urgent decompressive laminectomy.

Chemotherapy

Patients with primary tumours do not commonly get chemotherapy prior to presenting for surgery. Patients with metastases may well have had chemotherapy for their primary lesion. These drugs have important effects on the cardiac, respiratory and hematological systems. It is important to find out which drugs have been used and to assess the systems that those drugs commonly effect.

Aspirin, Heparin, Warfarin for TIAs

Many patients with carotid disease will be started on Aspirin. Those in whom this does not control the TIAs will be started on anticoagulants. This is usually with Warfarin in the chronic situation and Heparin acutely. Whether this has controlled their TIAs is important.

Neurobehavioural Evaluation

This is often performed pre- and postoperatively to assess the effects of surgery. This tests memory, attention span, spatial perception and higher cognition. Changes in areas of higher function may mean that someone who at first glance seems neurologically normal is in fact completely unable to function in normal society. These tests are usually carried out by a neuro-psychologist.

Past Medical History

Cardiovascular

The older a patient gets the more likely they are to have cardiovascular disease. In addition patients presenting for cerebrovascular disease, eg Carotid Endarterectomies or Cerebral Aneurysms have a greater incidence of cardiovascular disease. Patients with Acromegaly or Cushing's Disease (Pituitary tumours) also have an increased incidence of these types of disease.

The patient needs to be specifically asked about prior myocardial infarction, presence of angina (relationship with exercise, recent frequency, treatment), exercise capacity (often most easily quantified in terms of the number of flights of stairs (2 in a floor) that they can get up without a rest, nocturnal shortness of breath and ankle edema.

Those with a clear history of ischemic heart disease (IHD) or congestive cardiac failure (CCF) should be asked about investigation, eg stress tests, angiograms, echocardiograms and interventions to date, eg medications, angioplasties, coronary bypass. A determination of whether these interventions/treatments have had any beneficial effects is also important.

IHD is a relative contraindication to induced hypotension. Those with compromised cardiac function may also be less well able to tolerate the postural effects of the sitting position. A history of an ASD, VSD or probe patent Foramen Ovale is an absolute contraindication to the sitting position (due to the risk of paradoxical air embolus).

Myocardial infarction (MI) within the last 6 months is a relative contraindication to surgery however most neurosurgical procedures are not elective and postponement for this period of time is usually not prudent. In determining the best balance between cardiac risks and risks of delaying surgery one needs to assess the cardiac risk associated with the particular operation and anesthetic, obtain a cardiological review and do specific tests of cardiac function (echocardiograph) and ischemic potential (stress tests, thallium scans, coronary angiography). Clearly the greater the risks of delay, eg grade 1 subarachnoid hemorrhage the more likely it is beneficial to proceed. The critical point to remember is; will the patient be in a better state if I delay surgery and if so how long will this take. Someone in florid cardiogenic shock in the setting of subarachnoid haemorrhage will probably benefit from stabilisation over a day or two, someone with ECG changes and no other evidence of cardiac disease probably would not.

Respiratory

Many of these patients are smokers and the number and duration of cigarette exposure must be sort.

The patients exercise capacity must be assessed (as above) and what limits this determined, eg shortness of breath, angina, claudication etc. The presence of reversible airways disease (Asthma) must be sort, their treatments and current state sort. One needs to specifically as whether they assess this by using airflow meters (reliable) or clinical symptoms (unreliable). Adult onset asthma is often more difficult to control. The need for oral steroids, hospital admission and intubation/ventilation are important questions in determining the severity of their disease.

Endocrine

Diabetes Insipidus (DI)

This is associated with pituitary disease (posterior pituitary dysfunction). The patient will give a history of polyuria and polydypsia. Nocturia is also a useful clue in a your person. If they are being treated it is necessary to clarify what this is, how often it is taken and how effective it is. A patient with DI who becomes obtunded may rapidly become dehydrated and develop electrolyte abnormalities if inappropriate fluid replacement is used.

Diabetes Mellitus (DM)

Patients having intracranial surgery are often put on steroids. It is not uncommon for this to induce or worsen DM. A history of past high blood sugars, eg during pregnancy makes this more likely. A history of a patients DM includes an assessment of what type of control is needed, eg diet, oral hypoglycemic or insulin (insulin requiring) and whether they have had any episodes of ketoacidosis (insulin dependent).

The patient should also be able to tell you how good their recent control has been and what complications they have had with their DM. They have increased risk of vascular disease (cerebral, cardiac and periphery especially), renal disease and autonomic disease.

The management of DM perioperatively is outlined by Roizen pp 905-910.

Pan Hypopituitarism

This is not uncommon after pituitary surgery or with large pituitary tumours. Clinical symptoms are often minimal.

Pituitary adenomas may be associated multiple endocrine neoplasia type 1 (parathyroid hyperplasia/adenoma, Pancreatic islet cell hyperplasia/adenoma, pheochromoctoma and carcinoid syndrome).

Acromegaly

They complain of shoes and gloves no longer fitting and a deeper voice. They may also complain of polyuria and polydypsia (DM)

Cushing's Disease

They complain of weakness especially in getting out of a chair (proximal myopathy), central obesity, striae, easy bruising. They may also complain of polyuria and polydypsia (DM)

Hematological

Most neurosurgical operations do not allow the placement of drains and the compartments operated on are not distensible (intracranial and spinal operations) so that postoperative haemorrhage produces severe complications. A history of easy bruising, cuts that take a long time to stop, problems with bleeding after previous operations or dental procedures should alert one to the possibility of a bleeding problem which should be further investigated before surgery proceeds.

Renal Disease

Renal impairment is associated with vascular disease. Symptoms are slight until very advanced. Renal impairment is associated with platelet abnormalities and is also a relative contraindication to the use of Mannitol and Frusemide due to the risk of hypovolemia or osmotic induced renal failure. The use of contrast in CT scans must be restricted in the presence of renal impairment due to it's renal toxicity.

Fasting status

The time of the patients last oral intake should be noted. It is important to remember that for a trauma patient it is the time from last oral intake to the time of trauma that represents their fasting duration regardless of when they are having their operation.

Medications

Neurosurgical patients are often on a lot of medications. There are some specific concerns related to some of these:

Steroids may lead to DM

Aspirin, non-steroidal antiinflammatory drugs NSAIDs and Valproate may cause platelet dysfunction. Aspirin must be stopped for 7-10 days before its effect has passed. NSAIDs need to be stopped for 5 times their half life. Valproate causes platelet dysfunction in about 30% of patients however some centres still do craniotomies without stopping it.

Anticonvulsants, especially Phenytoin, Carbamazepine and barbiturates increase metabolism of steroidal muscle relaxants (Pancuronium, Vecuronium, Rocuronium).

Angiotension converting enzyme inhibitors may be associated with intraoperative instability with some authors recommending their discontinuation prior to surgery. This is not this authors practice.

Allergies

Patients who have spina bifida have a much higher than normal incidence of latex allergy. Symptoms of latex allergy should be specifically be sort in this group. Symptoms include previous allergies to latex products during surgery, facial edema or asthma with balloons, reactions to latex gloves, catheters. If symptoms suggestive of latex allergy are found then until the patient is tested they should be assumed to be allergic.

Social

The patients intake of alcohol, tobacco and other non-prescription drugs (legal and illegal) needs to be quantified.

Physical Examination

Trauma (table 5.1)

Assessment of Trauma patients should consist of a an initial look at the patient for obvious injuries and then a primary and secondary survey. One needs to consider other injuries such as Thoracic, Abdominal and long bone fractures.

Neurological

General

GCS (table 5.2)

This is the standard means of assessing the neurological state of a patient and is useful in management and prognosis. An unconscious patient is unable to protect their airway and would, if acute, be an indication for intubation. A GCS of ≤ 9 is usually said to be an indication for intubation and ventilation.

Signs of raised ICP

Papilledema and III and VI nerve palsies (due to brain shift).

Lesions, eg posterior fossa tumours and basilar aneurysms that obstruct the CSF pathways may present with evidence of raised ICP greater than would be expected on their size alone.

Coma is a severe manifestation of raised ICP.

Specific

Cranial Nerves

The following cranial nerves may need assessment in neurosurgical patients:

I - Olfactory Nerve

The loss of the sense of smell (Anosmia) in the absence of nasal problems or inflammation is associated with frontal lobe and pituitary lesions, meningitis or an anterior cranial fossa fracture. Unilateral Anosmia is much more likely to be significant.

II - Optic Nerve

Lesions distal to the optic chiasma produce monocular blindness (with no pupillary response to light in that eye but preserved response to light in the other eye), lesions pressing on the centre of the chiasma produce bitemporal hemianopia (pituitary tumours), lesion on the lateral aspect of the chiasma produce nasal hemianopia in the ipsilateral eye and lesions proximal to the chiasma produce homonymous hemianopia (loss of contralateral fields). Pupils should be checked in all neurosurgical patients.

III - Oculomotor Nerve

Controls pupillary size and response to light and all the intrinsic eye muscles except the external rectus and superior oblique. Complete III Nerve palsy results in ptosis, a divergent squint (effected eye looks down and out), pupillary dilation, loss of accommodation and light reflexes and double vision.

It is commonly effected in uncal and temporal lobe herniation.

IV, V, VI - Trochlear, Trigeminal and Abducent Nerves

Cavernous sinus lesions may produce III, IV, V and VI cranial nerve lesions as they all travel inside (III) or in the lateral wall of the cavernous sinus.

Lesions of the Ophthalmic branch of the V nerve produce loss of the corneal reflex which renders the patient more likely to corneal damage.

The VI nerve has a long intracranial course and is often effected in raised ICP and injuries to the base of the skull. The patient will complain of diplopia and will be unable to look laterally with the involved eye (convergent squint).

VII - Facial Nerve

The VII nerve supplies the muscles to the face and taste to the anterior 2/3 of the tongue.

It is sometimes effected by large cerebello-pontine tumours and is one of the common complications of surgery for these tumours. A proper preoperative assessment is vital in determining if a surgery related change has occurred.

VIII - Auditory Nerve

Unilateral hearing loss is the usual presentation for cerebellar pontine angle tumours, eg Acoustic Neuromas. Certain operations, eg Microvascular decompressions of cranial nerves (Janetta procedure) have a significant incidence of deafness and preoperative evaluation of hearing is important in determining if a surgery related change has occurred.

IX - Glossopharyngeal Nerve, X - Vagus Nerve

Supplies sensation to the posterior third of tongue and pharynx.

The gag reflex uses the IX nerve as its afferent limb and the X nerve as its efferent limb. Its absence increases the risk of aspiration. IX nerve dysfunction is rare in isolation. X nerve dysfunction often gives symptoms of speech changes, often nasal in nature due to paralysis of the palate.

Peripheral Nervous System

Testing for touch sensation can elicit the level of damage in patients with spinal cord injuries or compression.

The Phrenic nerve is supplied by C3,4 and 5 and patients who have low cervical myelopathy or low cervical lesions can breathe quite adequately despite losing intercostal and abdominal assistance to breathing due to continued diaphragmatic function (although respiratory reserve will be impaired). Once the level of the cord lesion gets to C5 and above the patient rapidly loses breathing function.

Reflexes testing are also useful in determining lesion levels, eg Biceps (C5/6), Triceps (C6/7), Upper Abdominal (T7/8/9), Lower abdominal (T11/12), Knee (L2/3/4) and Ankle (S1/2).

The Plantar Reflex is the response of the toes to stroking the lateral aspect of the sole of the foot, it normally produces a downgoing toe. The Babinski sign is an abnormal response and consists of an upgoing toe and fanning of the toes. It is present in upper motor neuron disease or pyramidal tract damage.

A simple screen for gross motor function is to check bilateral grasp and bilateral dorsiflexion noting for differences between sides and upper and lower limbs. Such a simple check should be performed on all neurosurgical patients.

Cardiac

General examination should include measurement of the BP and HR, examination for peripheral edema, raised JVP, auscultation of the heart (heart sounds and presence of valve lesions) and chest (basal crepitations), and assessment of the peripheral pulses (at least the upper limbs). In patients with vascular disease it is important to compare the pulses in both radial arteries and if any difference detected measure the BP in both arms. These patients may have subclavian stenosis and have quite different BPs in each arm. The arm with the higher BP is the one that should be used for BP measurement. The patient should be told about this difference.

Hypertension is very common in patients with vascular disease and in Cushing's disease and Acromegaly.

Respiratory

General examination should include respiratory rate and effort, the presence of cyanosis and auscultation of the chest. Specifically asking the patient to breathe in and out maximally gives an indication of vital capacity (this is often decreased in patients with scoliosis, cervical myelopathy and smokers).

Endocrine

The manifestations of Cushing's Disease (moon facies, central obesity, hirsutism, striae, easy bruising, proximal muscle weakness, plethora) and Acromegaly (coarse facial features, prognathism, large tongue, large feet/hands) may be seen.

Both are also associated with DM.

Airway

The airway must always be carefully assessed. In neurosurgical patients in particular Acromegalics have large jaws/faces and tongues which may make airway management and intubation difficult.

Patients having had temporal decompressions may have limited mouth opening (due to temporomandibular joint fibrosis).

Trauma patients may have facial, neck and larynx injuries that need to be carefully assessed.

Volume status

This needs to be carefully assessed in Trauma, DM, DI, obtunded patients, aneurysm patients and those who have had recent angiograms and fasting.

Nasal passages when nasal intubation planned

If a nasal intubation is planned it is important to exclude fractures to the base of skull and CSF leaks, both are contraindications.

Assessing which nostril is most patent is useful in the elective patient.

Laboratory Studies

Neurodiagnostic Studies:

Ideally one should look at the Neurodiagnostic tests directly however as these are often not available to us at least the test reports should be reviewed. Valuable information will be missed if this is not done.

CT/MRI

Hemorrhage

Hemorrhage shows as an area of high density (white) on CT. Extraaxial bleeding (extradurals, subdurals, and subarachnoidal) are commonly associated with trauma. Subarachnoid and intraventricular bleeding are associated with aneurysm rupture. CT will detect 90% of all subarachnoid bleeds in the first 24 hours. Isolated parenchymal bleeding is likely to be non-traumatic in nature (hypertension, tumours or vascular lesions). Cerebral contusions which consist of parenchymal microhemorrhages that coalesce to become visible on CT as ill-defined areas of high attenuation involving the gyral crests.

Fractures

The CT is superior to the MRI in diagnosis of skull fractures. CT is the imaging modality of first choice in head trauma.. The digital lateral scout view of the CT scan should always be assessed for skull or upper cervical spine fractures that may not be seen on the axial views.

Cerebral Edema (brain swelling due to excess water and sodium accumulation)

There are three types; Vasogenic, Cytotoxic and Interstitial however except for location the CT and MRI changes are similar. CT scans show a decrease in density (appears dark). The MRI shows increased water as decreased signal (black) on T₁-weighted studies and increased signal (white) on T₂-weighted studies. Contrast enhancement occurs early in vasogenic edema and later in cytotoxic edema.

Herniation Syndromes

Herniation of the brain matter may occur with non-uniform increases in ICP

Subfalcine (under the falx)

This is associated with ipsilateral lateral ventricle effacement but occasionally there may be an increase in size of the contralateral lateral ventricle because of foramen of Monro obstruction. The falx will be shifted over ("midline shift". There will be asymmetry of the six pointed star that represents the suprasellar cistern progressing to complete obliteration of this space.

Transtentorial (through the tentorial notch)

This is more ominous and may be descending (supratentorial lesions) or ascending (infratentorial, eg cerebellar lesions). The ascending type may be associated with enlarged ventricles due to aqueduct obstruction. The descending type can be unilateral or bilateral. the Uncus is displaced medially initially progressing to downward herniation.

Tonsillar (through the foramen magnum)

When there is increased pressure in the posterior fossa or transmitted pressure from the supratentorial space the cerebellar tonsils may herniate inferiorly through the foramen magnum. This is associated with medullary compression and death. Decerebrate posturing, respiratory disturbance and cardiac irregularities are common. Performing a lumbar puncture in this setting may be fatal as it increases the herniation by decompressing the CSF from below.

Transcalvarial (through a defect in the skull)

If the skull is not longer contiguous, brain may herniate out the defect. This is usually associated with a severe head injury.

Tumours

The CT scan and MRI will give the specific location and size of the lesion as well as giving some indication of their nature, eg glioma, meningioma, metastases. This gives information about the likely patient position, need for brain shrinkage (deep lesions). Tumour vascularity, presence of hydrocephalus, presence of surrounding edema and some indication of raised ICP can also be determined.

Hydrocephalus

In communicating hydrocephalus the obstruction occurs at the point of CSF absorption and all the ventricles (lateral, third and fourth) are dilated in proportion on CT. There may also be symmetric indistinct low density around the periventricular regions (interstitial edema). Herniation syndromes are not seen. In non-communicating hydrocephalus the obstruction occurs within the ventricular system and a portion of it will be dilated out of proportion to the rest. Herniation syndromes may then be seen.

Pneumocephalus

This may be seen on CT after skull fractures, post operatively (either air left in-situ or via CSF leaks), after pneumocephalograms or lumbar punctures. It's presence is a contraindication to the use of nitrous oxide.

Raised ICP

The signs of raised ICP on the CT are effaced cortical sulci, effacement of the basal cisterns and inter-hemispheric fissures, compressed ventricles (if hydrocephalus is not the cause) and herniation syndromes. There may also be a decrease in the size of the pituitary gland and even potential enlargement of the sella turcica associated with a partial empty sella.

Plain Skull films

Plain skull films whilst good for diagnosing fractures are much less sensitive in diagnosing intracranial pathology and the indications are limited to the investigation of penetrating injuries (especially for the course, location and number of gunshot fragments) the location of other foreign bodies and the presence and relationships of depressed skull fractures.

Positron Emission Tomography (PET) Scan

Allows in-vivo assessment of brain physiology and biochemistry and is useful in diagnosing grades of glioma and recurrent tumour from radiation induced necrosis. It's spatial resolution is not as good as CT/MRI.

Angiogram, Embolisation, Balloon occlusions and the Wada Test

It is always worth reviewing the angiogram report (if done) prior to anesthesia. Valuable information can be obtained about the vascularity of the lesion, if any vessels are involved or at risk during the procedure (which helps decide whether evoked potential monitoring is indicated, and if so, which type), the general state of the intracranial vasculature and the presence of cross filling (intracranial stenosis and absence of cross filling increases the risk of cross-clamp related cerebral ischemia in Carotid Endarterectomies). The Venogram also gives information about the risk of bleeding (in AVMs) and the general nature of the cerebral venous system.

Very vascular tumours and AVMs often have major feeding vessels embolised at the time of their angiogram. This substantially reduces the bleeding associated with surgery but carries the risk of hemorrhage, inadvertent occlusion of functional vessels and cerebral edema. It is important to know the extent to which the embolisation has or has not been effective. This aids in the planning of the extent of vascular access and the types of blood warmers and rapid infusion devices needed.

Sometimes when the surgeon wants to know if it is safe to occlude a major vessel, eg in a cavernous sinus aneurysm the radiologists will occlude the vessel when the patient is awake with a balloon and see if any neurological changes occur.

The Wada test involves the radiologist injecting a fast acting barbiturate into the cerebral circulation (intracarotid or posterior cerebral) and assessing the effects on each temporal lobe. Typically it is used to assess the suitability of a patient for temporal lobectomy for epilepsy. The aim is to identify the lobe which is dominant with regard to language and memory.

Carotid Ultrasounds

It is important to know the degree of the stenosis when a patient presents for carotid endarterectomy, in addition the presence of contralateral stenosis or occlusion makes it more likely that ischemia (however detected) will occur with cross clamping of the carotid. A patient presenting for other types of neurosurgical procedures should have preoperative

carotid ultrasounds should a murmur be detected over the carotids. The presence of an asymptomatic stenosis if severe may warrant this being addressed prior to other procedures, If left untreated a carotid stenosis makes it more likely that hypotension during surgery will cause cerebral ischemia.

Transcranial Doppler

This is done commonly on patients who have had a subarachnoid haemorrhage in order to detect the presence of vasospasm (the diagnosis made on the basis of increased flow velocity). The presence of vasospasm even if subclinical is a relative contraindication to induced hypotension and a risk should inadvertent hypotension occur.

Visual Fields (pituitary surgery)

Pituitary tumours will often effect the visual fields and this may be worsened by surgery (often temporarily). Visual fields are done routinely prior to this type of surgery.

What tests do we need?

Much is written about the need to be selective in the tests we order preoperatively however the neurosurgical patient, in general is different. The disease processes that they have or are associated with mandate the following routine tests:

Electrolytes - Na/K/Cl/TCO₂/Glucose/Ca (albumen if low)

Electrolyte disturbances are common both pre- and post operatively. Changes in serum Na are associated with marked changes in brain volume. Potassium loss is common with diuretics and steroids. Chloride and Total CO₂ help delineate common electrolyte disturbances. Glucose is needed as hyperglycemia is common with steroids and endocrine abnormalities and is a clear risk when cerebral ischemia may occur.

Hypo- and hypercalcemia are common in malignancy and hypocalcemia is a risk for seizures. If the calcium is low then one needs to check the albumen concentration as hypoalbuminemia will produce artifactual hypocalcemia (50% is bound to albumen).

LFTs

These are needed in patients on anticonvulsants, especially Phenytoin as hepatic toxicity is not uncommon.

FBC

Should be done on all neurosurgical patients. Platelet count helps determine risks of bleeding. Haemoglobin helps determine risk of cerebral and cardiac ischemia and provides a baseline should bleeding occur. The white cell count is useful as a guide to infection but is often elevated with steroid usage.

Coagulation tests

If the patient gives a history suggestive of a bleeding disorder then an PT (prothrombin time) and PTT (partial thromboplastin time) should be done to assess coagulation. If these are abnormal further tests need to be done to elucidate the exact coagulation disorder and the most appropriate perioperative management. A haematologist's advice should be sort in this situation. Often for intracranial and spinal surgery, because of the major consequences of post operative haemorrhage these tests are done as screening tests. No evidence to support or refute this practice exists for neurosurgical patients.

Platelet Function tests

Patients who have had drugs which interfere with platelet function should have these tested if the consequences of bleeding are great (intracranial surgery) or if the procedure can not be delayed until the drugs and their effects have passed. Even if one proceeds the tests are useful because if bleeding occurs intraoperatively and the platelet function tests are normal then no indication exists to give platelets unless major bleeding has occurred. Platelet function tests take hours to perform and can not be done emergently.

Cardiac Studies

ECG

Males over 40, Females over 50. Any patient with a history of cardiac disease or indicative of an increased risk of cardiac disease, eg hypertension, hypercholesterolemia, diabetes, cerebral aneurysm, vascular disease in other sites or electrolyte abnormalities. Patients in whom induced hypotension may be used, eg AVMs who might not have other indications should also have one.

Echocardiography (2D), Dobutamine Echo.

Patients who have or may have impaired cardiac function or valvular disease. May also be part of the workup for patients having operations in the sitting position to detect the presence of a patent foramen ovale.

Stress ECG tests, Exercise Thallium scans, Dipyrimadole Thallium

These are all used to delineate the nature of chest pains or the significance of ECG changes. Elective patients who can exercise would usually have a stress ECG first (\pm combined with a thallium scan). Those who can't exercise are given dipyrimadole to induce intracoronary steal and simulate exercise. The exact indications for these is not clear at this time and consultation with a cardiologist is suggested if significant cardiac disease is suspected.

Coronary Angiography

This is the gold standard to diagnosed coronary artery disease. Left ventriculography also give an indication about left ventricular function and aortic and mitral valve function. Angioplasty may be possible at the same time if a suitable lesion is present.

Respiratory Function tests

Spirometry

These should be done any any patient with pulmonary disease or where respiratory reserve may be compromised (cervical myelopathy, scoliotic patients).

Blood Gases

These should be done where the patient has marked pulmonary disease. Diagnosis of patients with carbon dioxide retention warns of a group with minimal respiratory reserve. Patients with pre-existing hypoxemia will need pulse oximetry monitoring for a least 2 post operative nights.

Chest X-Ray

This is indicated only in patients with cardiovascular disease, significant pulmonary disease, evaluation of an abnormal trachea and where a suspicion of tuberculosis or intrathoracic malignancy is considered.

Sleep Apnoea

Patients with a history of this condition need to have their CPAP systems available for them in the PACU and need post operative pulse oximetry monitoring. Those with a history suggestive of this condition should be evaluated prior to elective surgery due to the risks of post operative hypoxemia.

Implications of disorders of:

Hb

Hb <10gm/dl may lead to a greater incidence of myocardial or cerebral ischemia (unless chronic), routine administration of blood to raise Hb preoperatively is no longer justifiable. A Hb >16 (polycythemia) is associated with a greater risk of complications, reducing this below 16 appears to reduce complications.

Platelets

Platelet counts <75,000 should have preoperative platelet transfusions.

When platelet function tests are mildly impaired function and the surgery has a low risk of bleeding then it may be reasonable not to order platelets to be cross-matched and only get them if evidence of inappropriate bleeding occurs.

If the function is markedly impaired, the surgery involves a significant risk of bleeding and can not be delayed to allow a drug induced effect to resolve then platelets should be given preoperatively (usually immediately preoperatively). They usually need to be repeated in the postoperative period.

Coagulation (PT, PTT)

Abnormalities of these test preoperatively need to be resolved with more detailed testing. Vitamin K deficiency and liver disease will elevate the PT, Haemophilia and lupus inhibitors will elevate the PTT. Once the specific cause is found the deficiency should be treated perioperatively.

Bleeding times

Increased bleeding times are associated with drugs that interfere with platelet function however the tests ability to predict which patients will or won't have bleeding problems is poor and there seems little place for its use.

Serum/Urine Osmolality

These usually form a baseline for further changes. Rapid correction of chronic hyperosmolality secondary to hypernatremia will lead to cerebral edema. Hyperosmolality due to uremia is without importance in the genesis of cerebral fluid shifts as urea is relatively freely permeable to the blood brain barrier and hence has no osmotic effects. Hypoosmolality should be corrected preoperatively to reduce the likelihood of cerebral edema formation.

Fluid Balance

Hypovolemia will make any vasospasm more likely to become clinically apparent and will lead to a greater risk of intraoperative hypotension. Ideally the patient should have a normal volume state preoperatively.

Electrolytes

Hyper- and hyponatremia are associated with hyper- and hypoosmolality.

Hypokalemia should have some correction preoperatively as the use of diuretics will lead to further potassium loss. It is important to recognise that hypokalemia usually represents a substantial (2-300mmol) potassium deficit and can not be rapidly corrected safely. There is little of no increase anaesthetic risk with a potassium ≥ 3.0 mmol/l.

Chloride deficits are associated with non-respiratory alkalosis.

Hypocalcemia and hypomagnasemia increase the likelihood of seizures.

Hypercalcemia may occur in patients with bony metastases or those which secrete parathyroid hormone.

Blood Products

Each hospital needs to determine it's policy towards this issue. In general except where blood may be needed immediately (cerebral aneurysms or very vascular tumours/AVMs) group and screening is used when a blood transfusion may be needed.

All intracranial surgery and major spinal surgery should have a group and screen. In the absence of antibodies the risk of a transfusion reaction to group specific blood is less than 1 in 10,000 units. Some hospitals now do computerised cross matches where no physical cross match is done, others only cross match the first unit as a check that the ABO grouping has been done correctly.

Communication with Surgeon

Unless one is completely familiar with a particular surgeons practice then it is wise to clarify the following with a member of the surgical team:

Patient's position

Ideally the surgeon will indicate on the operation list the position of the patient. If you need to know this to plan which side to put the lines in and what extra items may be needed for this position. Sitting position cases involve extra preoperative investigations and special operating table equipment.

Position of equipment and instruments

This will help you plan your access to the patient and the position of your anaesthetic machine. Ideally the position of our equipment and the surgeons equipment will be a compromise that meets both parties needs not just those of the surgeon.

Temporary Occlusion vs. Induced Hypotension for aneurysms

This is the topic of much debate however one needs to know which particular technique will be used as this will partially determine the blood pressure during aneurysm dissection. In addition the presence of cerebral vasospasm, coronary or renal disease are relative contraindications to induced hypotension

Intraoperative studies, eg angiograms need access to groin, ultrasounds

If these are planned then access to these sites must be provided for.

Plans for post operative care

Patients having intracranial surgery should be managed for the first postoperative night in an area that allows close monitoring (including invasive pressure monitoring). Patients who have other illnesses that need careful post operative care may also need a similar area.

Pain management should be discussed with the patient especially if a specialised form of pain management is to be used, eg patient controlled analgesia. The Acute Pain Service may need to be contacted to reserve a pump in such cases.

If it is planned to leave a patient intubated post operatively, eg high cervical surgery in a patient with poor respiratory function preoperatively then this must be carefully explained to the patient so that they will not become unduly distressed when they wake up.

Awake Techniques

In surgery near eloquent areas of the brain it is sometimes the practice to perform the procedure under local anaesthesia to allow cerebral mapping, eg epilepsy and AVM surgery. The entire process needs to be clearly explained to the patient so that they fully understand what is going to happen and what their responsibilities are. They are likely to be extremely anxious and need considerable explanation and reassurance. Often the single best way to alleviate this (as with all fears of anaesthesia) is the simple reassurance that you will be with them the whole time they are in surgery and will be immediately available to help them should problems arise.

Patients having scoliosis surgery may also need to be woken up during their procedure if evoked potential monitoring is equivocal. Again a full explanation of what will happen is needed.

Anaesthetic Techniques when Neuromonitoring used

If neuromonitoring is being used and is not being done by the Anaesthesia team then it is necessary to know what types are being used and how this is effected by the anaesthetic technique. In general if one is trying to infer that changes relating to surgery or blood pressure are causing the monitoring to change then it is necessary to ensure that the concentrations of drugs that effect this monitoring need to remain constant. Most neuromonitoring is very sensitive to drugs that effect the CNS.

If a motor response is needed, eg facial nerve monitoring then paralysis needs to be avoided or limited to allow a response to be measured.

Centres that use these techniques will usually have developed anaesthetic protocols that have the minimum effect on neuromonitoring, you should check to ensure you are aware of these. Failure to follow these may mean the surgery may not be successful.

Availability of ICP monitoring during induction of anaesthesia

Unless the patient has an ICP monitor in prior to induction I do not consider their any indication to institute this prior to induction of anaesthesia. If it is insitu then you should ensure that you are able to monitor it.

Monitoring

It is necessary to plan what monitoring modalities will be used in the case so that the patient can be informed about this and, in the more complex monitoring, this can be arranged for the procedure.

It is important to understand why we are monitoring a patient. All monitoring is dangerous and this varies from the real (rupturing pulmonary arteries with swan-ganz catheters) to the theoretical (microelectrocution) to the practical (it may distract you from other more important concerns). It does not of itself confer a benefit, it may warn you of important changes but does not usual of itself make the appropriate response. Benefit is therefore gained by making the correct management changes as result of the information obtained. This also means that if you make the wrong decision you may harm the patient. Monitoring is fundamentally about gaining sufficient information to make the appropriate management decisions about your patient. Only when the benefit of gaining this information outweighs the risks should a particular type of monitoring be used.

Table 5.3 outlines monitoring for typical cases.

Suggested Reading

Roizen MF: Anesthetic Implications of Concurrent Diseases, Anesthesia 4th Edition. Edited by Miller RD. New York Churchill Livingstone 1994, pp 903-1014

Roizen MF: Preoperative Evaluation, Anesthesia 4th Edition. Edited by Miller RD. New York Churchill Livingstone 1994, pp 827-882

Fischer SP: Preoperative evaluation of the adult neurosurgical patient. International Anesthesiology Clinics. 1996 34(4):21-32

Laine JL, Smoker WR: Neuroradiology, Anesthesia and Neurosurgery 3rd Edition. Edited by Cottrell JE, Smith DS. St Louis Mosby 1994, pp 175-209

Smith RR, Caldemeyer KS: Increased Intracranial Pressure and Cerebrospinal Fluid Spaces. Seminars in Ultrasound, DT, and MRI 1996; 17(3): 206-220

Table 5.1. Trauma Patient Examination

- 1) Look for obvious Injuries
 - 2) Primary Survey
 - A Airway**
 - Look for chest wall movement, retraction and nasal flaring
 - Listen for breath sounds, stridor and obstructed breathing
 - Feel for air movement
 - B Breathing**
 - Look to see if ventilation is adequate
 - Look for open pneumothorax, open chest wound, or flail segments
 - Listen for bilateral chest sounds
 - C Circulation**
 - Feel peripheral pulses, measure blood pressure and capillary refill
 - Perform an ECG
 - D Disability (Neurological state)**
 - Check level of consciousness
 - A Alert**
 - V** responds to **V**ocal command
 - P** responds to **P**ainful stimulus
 - D** unresponsive
 - Check pupillary response to light
 - E Expose patient fully for complete examination**
 - 3) Secondary Survey
-

Table 5.2. Glasgow Coma Score

Eye opening	
Spontaneous	4
To speech	3
To pain	2
None	1
Verbal Response	
Oriented	5
Confused conversation	4
Incomprehensible words	3
Incomprehensible sounds	2
Nil	1
Best Motor Response	
Obeys	6
Localises	5
Withdraws	4
Abnormal flexion	3
Extensor response	2
Nil	1
Total	15

Table 5.3. Monitoring for typical Surgical Cases*

Arterial Line

- Intracranial surgery
- Operations done in the sitting position
- Craniofacial reconstructions
- Surgery on the cervical spine done in the prone position
- Carotid Endarterectomy
- Trans-sphenoidal hypophysectomy
- Operations lasting longer than 4 hours
- Operations in which large blood loss is expected.

Central Venous Catheter

- Intracranial surgery
- Craniofacial reconstructions
- Carotid Endarterectomy
- Operations in which large blood loss is expected
- Operations in which vasopressors are needed
- Operations with a risk of air embolus[#]

Swan Ganz Catheter

- Cerebral Aneurysm and poor LV function

Somatosensory Evoked Responses

- Cerebral Aneurysm surgery
- Tumours involving major intracranial arteries
- Tumours involving the brainstem
- Spinal distraction surgery
- Surgery for spinal fractures, especially cervical

Brain Stem Auditory Evoked Potentials

- Microvascular Decompression of cranial nerves (Janetta procedure)
- Tumours around the 8th nerve, eg acoustic neuromas
- Vestibular nerve sections
- Pontine Brainstem tumours

EEG

- Surgery on the extracranial carotid, eg carotid endarterectomy
- Cerebral Aneurysms of the ICA/MCA
- When cerebral protection with barbiturates are planned

Cortical Mapping

- Epilepsy Surgery
- Tumours in eloquent areas

Precordial Doppler

- When air embolus is a risk, eg sitting position cases.

Transesophageal Echocardiography

- Cerebral Aneurysms done with femoral-femoral bypass
- When air embolus is a risk and the patient has a patent foramen ovale

Transcranial Doppler

- Carotid Endarterectomy
- Cerebral Aneurysms (when spasm present)

*Assumes that all patients will have SpO₂, ETCO₂, ECG, Temperature, oesophageal stethoscope and NIBP as well.

[#]In this case the catheter must be a single lumen multiorifice catheter with its tip at the junction of the Superior Vena Cava and Right Atrium (done with ECG or X-ray guidance)