Preoperative Evaluation of the Adult Neurosurgical Patient

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Preoperative knowledge of the pathophysiological characteristics of neurosurgical disorders is essential for the formulation of an anesthetic plan for intra- and postoperative patient management. The goal of this chapter is to provide the clinical information needed to rationally approach the preoperative evaluation of the neurosurgical patient. Several associated medical conditions such as cardiac dysfunction and hemodynamic changes may occur with primary neurosurgical disorders and will be reviewed. A suggested protocol for screening and enhanced preoperative neurological examinations will be presented together with suggested preoperative laboratory and diagnostic studies for the neurosurgical patient.

Preoperative Neurological Examination

The purpose of the neurological examination for the anesthesiologist is: (1) to determine the general location and extent of the neurological lesion, (2) to document in the anesthesia record the presence or absence of nervous system malfunction for perioperative comparison, (3) to determine and record the patient's preoperative physical status and stability, and (4) to develop an appropriate anesthesia management plan. Preoperative neurological assessment involves evaluation of both peripheral and central nervous system function. The neurological examination should be performed in exactly the same manner each time, proceeding from higher to lower levels of integration so that no step is omitted. Very little specialized equipment is required and a portion of the examination, for example, tests for general cerebral function, can be accomplished while taking the patient's history. The preoperative physical examination of other organ systems (e.g., pulmonary, cardiac, etc) should be done before the neurological examination in order to integrate other physical findings with the presenting neurological abnormality. For example, a patient hyperventilat-

ing secondary to severe emphysema may have neurological evidence of altered mental status, paresthesias, carpopedal spasm, tetany, and dizziness. The primary medical disorder in this case is pulmonary and not neurological.

The Screening Neurological Examination

An abbreviated neurological evaluation for the patient without apparent neurological disease should be performed in all patients undergoing anesthesia. If an anesthesia technique (general or regional) can affect an organ system, then that organ system should be evaluated and documented preoperatively by the anesthesiologist. To screen the musculoskeletal or motor system, observe the patient's gait, ability to perform toe and heel walk, and ability to maintain the arms held forward and evaluate the patient's grip strength. Sensory system screening includes the physical distinction of vibration, pain, and light touch on the patient's hands, feet, and limbs. Superficial reflexes and reflexes of the deep tendons can be assessed easily and quickly. Cranial nerve abnormalities can often be elicited by patient history and by observation. Mental status (appearance, mood, thought processes, cognitive function) and speech pattern are typically revealed by interaction with the patient.

The Enhanced Neurological Examination

A focused neurological exam for patients who are known to have neurological disorders is described in this section.

Tests for Cerebral Function General cerebral abnormalities may cause disturbances in emotional status, communication, intellectual performance, behavior, and level of consciousness. Specific cerebral function testing such as sensory interpretations (the recognition of objects by sight, sound, and touch), motor integration (the ability to carry out a purposeful physical action), and language (the understanding and communication in spoken or written form) can reveal specific cortical areas of dysfunction (**e.g.**, frontal, parietal, temporal, or occipital lobes).

Cranial Nerve Evaluation Detailed testing of all twelve cranial nerves (CN) can be reviewed in a standard medical textbook. Six of the cranial nerves when dysfunctional can affect patient management during anesthesia.

The olfactory nerve (CN I) controls the sensation of smell. The loss of smell (anosmia) without nasal disease or inflammation suggests a frontal lobe or pituitary lesion, meningitis, hydrocephalus or an anterior fossa skull fracture. Anesthesia implications include increased intracranial pressure (ICP), cerebral hemorrhage, and signs and symptoms of meningeal infection.

Testing: Evaluate each nostril separately, asking the patient to identify some common odors.

The oculomotor nerve (CN III) controls pupillary size and the response to light. Preoperative pupil size should be recorded to provide baseline data for subsequent assessment of anesthetic depth, narcotic effect?and for comparison with postoperative pupil changes.

Testing: Perform a bilateral comparison of pupil size and reaction of both pupils to a bright light.

Patients with trigeminal neuralgia (CN V) have unilateral symptoms usually confined to the second (maxillary) or third (mandibular) division of this nerve. Symptoms are characterized by sudden, lightening-like paroxysms of severe pain. Most trigeminal neuralgia is probably caused by compression of the nerve by tortuous posterior fossa arteries. The anesthesiologist can precipitate an attack of pain if the face mask touches trigger zones around the lips or buccal cavity. Severe pain and deviation of the mandible to one side can occur with mouth opening in patients with trigeminal neuralgia. Consequently, patients may be reluctant to open their mouth fully during examination or at the time of anesthesia induction.

Testing: Motor—examine bilateral strength of temporal and masseter muscles while the patient clenches his or her teeth.
Sensory—with the patient's eyes closed, test forehead, cheeks, and jaw for light touch and temperature (alcohol wipe) sensations.

The facial nerve (CN VII) innervates muscles for facial expression, mobility, and symmetry and provides sensory innervation for taste sensation. The facial nerve may be damaged by face mask pressure, surgery, or positioning. A baseline evaluation and documentation of any abnormality is appropriate prior to anesthesia induction.

Testing: Motor—evaluate patient's ability to raise eyebrows, frown and smile, close eyes tight, and puff cheeks.

The glossopharyngeal nerve (CN IX) supplies sensory fibers to the mucosa of the pharynx and soft palate. Glossopharyngeal dysfunction can cause severe pain that is similar to trigeminal neuralgia. The trigger zone lies in the posterior pharynx and tonsillar area. Stimulation of this area with an oral airway or laryngoscope can result in severe pain locally that spreads toward the angle of the jaw and ear. Additionally, patients with CN IX disorders can experience reflex bradycardia and hypotension during pain episodes, secondary to intense afferent discharge of the glossopharyngeal nerve.

Testing: Palatal reflex—stroke each side of the mucous membrane of the uvula. The side touched should rise if the nerve is intact.
Pharyngeal gag reflex—touch posterior pharynx with tongue depressor to elicit gag.

The vagus nerve (CN X) supplies motor fibers to the pharynx, soft palate, larynx, and trachea. The motor and sensory supply of the trachea and larynx are the superior and recurrent laryngeal branches of the vagus nerve. Hoarseness of the voice ma): indicate vocal cord paralysis. The anesthesiologist may observe tachycardia in patients with a damaged vagus nerve.

Testing: Observe patient's ability to swallow and speak without hoarseness and the movement of the patient's soft palate symmetrically when saying "ah."

Cerebellar Function Balance and coordination are controlled by the cerebellum. Disturbance in physical movements, tremor, and ataxia suggest cerebellar insult (tumor, ischemia, infarction). Evidence of cerebellar damage is suggested when a patient demonstrates ataxia especially with the eyelids opened.

The Motor System Muscle strength, tone, and size should be evaluated for asymmetry. Additionally, increased resistance to passive muscle stretching is observed in upper motor neuron lesions and in Parkinson's disease. There are anesthesia management concerns in patients with upper motor neuron diseases, hemiplegia, and paraplegia. For example, succinylcholine given to these patients may precipitate a hyperkalemic response.

The Sensory System Evaluation of the peripheral sensory system is important before any regional anesthetic technique. The patient's ability to discriminate temperature and pinprick sensation will be used to determine if a regional procedure is successful. A patient with diabetes, for example, may have impaired sensation, especially in the lower extremities. Upper or lower extremity dysfunction (motor or sensory) may suggest that a regional anesthesia technique is undesirable.

Reflex Testing There are three types of muscle reflexes, categorized as deep, superficial, and pathological. The site of the reflex stimulus and response corresponds to a specific central nervous system (CNS) segment. The deep tendon reflexes, including biceps (cervical level 5, 6), patellar (lumbar level 2, 3, 4), and achilles (sacral level 1, 2), are easily tested. Superficial reflexes also delineate CNS segment functionality and are tested by stroking the skin with an object such as a tongue depressor. For example, the upper abdominal reflex corresponds to thoracic segments 7, 8, and 9. The lower abdominal reflex relates to thoracic segments 11 and 12. Increased reflexes are observed in patients with hyperthyroidism and upper motor neuron disease. Decreased reflexes such as a slowed relaxation phase in the ankle reflex are observed in hypothyroidism. Patients with clinical signs and symptoms of hypo- and hyperthyroidism present an increased concern for the anesthesiologist.

The most common pathological reflex is the Babinski sign, which is performed by stroking the lateral aspect of the sole of the foot. In pyramidal tract or upper motor neuron disease, a dorsiflexion of the big toe occurs (in addition to fanning of the toes) indicating the presence of the Babinski reflex.

• Craniotomy for Intracranial Tumors

Preoperative Evaluation

Intracranial tumors present preoperatively according to their growth rate, size, location, and the consequences of intracranial pressure [1]. Slow growing tumors may present with few symptoms. A rapidly expanding mass often evokes acute neurological compromise with readily apparent symptoms. The preoperative assessment of a patient presenting with an intracranial tumor is directed toward determining if increased ICP is present. Table 1 lists the etiologies of increased intercranial pressure.

Signs and symptoms of increased ICP include: (1) nausea and emesis, (2) headache, often worsened by cough, (3) altered mental status, (4) decreased alertness, (5) hypertension, (6) seizures, (7) visual disturbances, (8) papilledema, (9) unilateral pupillary dilation, (10) abducens (CN VI) or oculomotor (CN III) palsy, and (11) neck rigidity. If the abducens nerve is involved, the patient will be unable to look laterally with the involved eye. Oculomotor nerve dysfunction prevents the patient from looking down, up, or medially.

As ICP continues to increase, there may be evidence of brain herniation, manifested by: (1) apnea, (2) dilated and unreactive pupils, (3) contralateral hemiplegia, (4) decreased consciousness, and (5) bradycardia. A preoperative neurological assessment should be documented, and an electrocardiogram should be obtained to document bradycardia or other rate-related cardiac changes suggesting ischemia or conduction deficits.

The preoperative evaluation for pituitary tumors [2] should include

Table 1. *Etiologies of Increased Intracranial Pressure*

Cerebrovascular hemorrhage
Intracranial tumor
Head trauma
Infection
Hypertensive and metabolic encephalopathy
Hydrocephalus
Cerebral ischemia (with cerebral edema)

assessment of endocrine dysfunction, fluid and electrolyte status, visual loss, headache, and cardiac disease. There is an increased association of coronary artery disease and cardiac hypertrophy in patients with pituitary tumors. Patients may also manifest signs and symptoms of Cushing's disease, which includes hypertension, diabetes, mental status changes, and muscle weakness. Patients may already be taking corticosteroids, diuretics, and anticonvulsant medications to decrease the potential for increased ICP. Each of these drugs can have an effect on the anesthesia perioperative management plan.

Many neurological procedures require unusual patient positions such as prone or sitting [3, 4]. The sitting position, as with posterior fossa surgery, presents the potential for postural hypotension in patients who are often volume depleted from diuresis and fluid restriction. Preoperative evaluation of the patient's volume status is imperative.

■ Craniotomy for Vascular Diseases

Preoperative Evaluation

Neurosurgical vascular lesions include intracranial aneurysms and arteriovenous malformations (AVM). The patient with an intracranial aneurysm [5] may demonstrate preoperative signs and symptoms of a nonspecific nature, depending on whether or not the aneurysm has previously bled. Patients may report headaches, orbital pain, dizziness, and mild sensory or motor abnormalities. With the rupture of an intracranial aneurysm, the presenting signs and symptoms are usually similar to hemorrhage in the subarachnoid space [6–8] or of a rapidly expanding intracranial tumor. A patient may manifest signs and symptoms of: (1) increased ICP secondary to hemorrhage, (2) focal neurological signs, (3) a 'depressed level of consciousness, (4) nausea and emesis, (5) hypothermia, (6) the triad of meningeal irritation (photophobia, headache, and meningismus), (7) cranial nerve palsies, and (8) seizures. Additionally, a ruptured intracranial aneurysm with increased ICP may affect the electrocardiogram causing ST-segment elevation or depression, the presence of U waves, a prolonged QT interval and T-wave inversion or flattening. These changes usually do not correlate with cardiac instability during the neurosurgical procedure [9, 10]. Preoperatively, the primary focus should be directed toward controlling systemic hypertension. Additional laboratory findings of coagulopathies [11], leukocytosis, glycosuria, and proteinuria may occur in these patients.

The preoperative evaluation of patients with arteriovenous malformations is similar to patients with aneurysms. The anesthesiologist inquires about a history of seizures, the signs and symptoms of intracranial hemorrhage, and hypertension. Occasionally, a large AVM can precipitate high output cardiac failure secondary to high AVM flow.

Carotid Thromboendarterectomy

Preoperative Evaluation

Patients presenting with carotid artery [12, 13] or vertebrobasilar arterial disease usually have manifested signs or symptoms of either a transient ischemic attack (TIA) or a completed stroke [14, 15]. There is an associated higher incidence of hypertension and coronary artery and valvular heart disease in patients presenting with cerebrovascular occlusive disorders. A careful cardiovascular evaluation is imperative, including comparison of the current electrocardiogram with previous tracings. Uncontrolled systemic hypertension should be treated preoperatively without lowering blood pressure to a level that precipitates ischemic symptoms. There is also an association of cerebrovascular occlusive disease with diabetes mellitus [16]. Cerebral and lacunar infarction occurs with the thrombotic or embolic occlusion of a cerebral vessel. The neurological deficits are related to the particular vessel(s) involved and the extent of any collateral circulation. TIAs are characterized by focal ischemic deficits that usually last from minutes up to 2 hours [17, 18]. Approximately 30% of patients with a history of stroke have had TIAs. Table 2 reviews the clinical findings of a patient with TIAs. Since TIAs are transient, patients may have a normal exam at the time of their assessment.

Patients with cerebral infarction secondary to carotid artery occlusion may present various neurological deficits including: (1) contralateral extremity motor and sensory loss, (2) vertigo, (3) diplopia, (4) amnesia, (5) presence of a contralateral grasp reflex (a clawing movement of the patient's fingers to stroking the palmar surface), and (6) behavioral changes (often best described by the family). Patients who progress to a completed intercerebral stroke secondary to embolic ischemia or hemorrhage may manifest additional signs of increased ICP, cerebral edema, coagulopathies, stupor, or coma [19].

Patients may have symptoms of TIAs with certain head and neck positions. These patients usually have a history of severe cervical arthritis and

Table 2. Signs and Symptoms of Transient Ischemic Attacks

Carotid Territory	Vertebrobasilar Area
Contralateral arm, leg, face weakness with paresthesias or numbness	Weakness. paresthesias, or numbness in either or both sides
Dysphasia	Dysarthria
Monocular visual loss (contralateral to the affected limbs)	Diplopia, visual dimness, or blurring
Hyperreflexia	Ataxia
Extensor plantar response on the affected side	Drop attacks or falling to floor from leg weakness
	Vertigo

spondylosis. In the operating room, careful head positioning is essential to avoid precipitating cerebral ischemia. A carotid bruit may be present or absent in these patients [20, 21]. The diseased carotid artery should not be palpated during an examination to avoid the possibility of dislodging and embolizing a carotid plaque. Patients may indicate awareness of TIA symptoms associated with lowered blood pressure, for example, when taking antihypertensive medications. This information can provide the anesthesiologist with a lower blood pressure limit during surgery, to avoid the potential for cerebral ischemia.

■ Spinal Neuroanesthesia

Preoperative Evaluation

Spinal neurosurgery includes several operative procedures secondary to injury, tumor, spinal stenosis, and aging. There are similarities in the preoperative evaluation of these patients with signs and symptoms attributed to spinal cord or nerve root compression [22–24]. Often these patients are healthy and their first complaint is localized spinal segmental pain with or without radiation to an extremity. Patients with spinal nerve compression develop weakness and atrophy in muscle groups of the affected extremity. Patients should be evaluated preoperatively for changes in motor and sensory function in the affected extremities for postoperative comparison.

■ Craniotomy for Head Trauma

Preoperative Evaluation

The assessment of a patient presenting with a head injury is often influenced by the extent of the injury and whether it has caused open or closed skull trauma [25–27]. Associated trauma such as abdominal injuries and long bone fractures may be present. Patency of the airway, ventilation, and treatment of shock are the initial focus of the anesthesiologist. The preoperative evaluation is then primarily directed toward the absence or presence of increased ICP.

The Glasgow coma scale [28] (Table 3) can assist the anesthesiologist in head trauma patient evaluation and suggests the urgency of a patient's need for intubation and neurosurgical intervention [29]. The Glasgow coma scale assigns a score to functions of verbal response, motor response, and eye opening. Total points are utilized to indicate the status of a patient's neurological function and deficits.

In patients with acute head trauma, the preoperative evaluation must proceed concomitantly with management of unstable or urgent conditions [30]. Seizures may accompany cerebral trauma and suggest the expansion of an intracranial hematoma. Both hypertension and hypotension [31] are manifestations of head injuries and require immediate treatment. Comatose patients with decerebrate or decorticate posturing have severe hemispheric dysfunction and deterioration and probably require intubation.

Table 3. *Glasgow* **Coma** *Scale*

Response	Score*
Eye Opening	
Spontaneous	4
To speech	3
To pain	2
None	1
Best Motor Response	
Obeys	6
Localizes	5
Withdraws (flexion)	4
Abnormal flexion	3
Extensor response	2
None	1
Verbal Response	
Oriented	5
Confused conversation	4
Inappropriate words	3
Incomprehensible sounds	2
None	1

'Patients with a scale score less than 7 usually require intubation and hyperventilation. Approximately 50% of these patients die or remain in a vegetative state.

The preoperative assessment may be limited by the extreme urgency to proceed to the operating room. In addition to laboratory and diagnostic tests, a drug screen [32–34] should be performed in head trauma patients since illegal and prescription drugs may influence intra- and postoperative anesthesia management.

■ Cost-Effective Preoperative Laboratory and Diagnostic Testing

The value and utility of preoperative diagnostic studies have become a central issue in evaluating cost-effective health care in the surgical patient [35–40]. It is estimated that up to three billion dollars are spent in the United States annually in preoperative laboratory and diagnostic studies. The use of preoperative testing as a screening tool to detect disease and to determine stability of a patient for surgery has been the focus of numerous studies. These studies have compared the clinical yield from indicated versus unindicated preoperative testing for electrocardiograms [41], chest roentgenograms [42, 43], blood chemistries, and hematological studies [44, 45]. Additionally, the value of preoperative pulmonary function testing and the utility of bleeding time determination [46] has been questioned. Most studies conclude that unwarranted preoperative tests do not change perioperative care [41–47] and substantially contribute to increased hospital costs. Unnecessary testing is inefficient, expensive, and requires additional technical resources. Inappropriate studies may lead to evaluation of

Table 4. *Guidelines for Laboratory and Diagnostic Studies in Otherwise Healthy Neurosurgical Patients*

	General Anesthesia	
Age	Men	Women
12–39 y	None	CBC
		? Pregnancy test
40–49 y	Electrocardiogram	CBC
		? Pregnancy test
50–64 y	CBC	CBC
	Electrocardiogram	? Pregnancy test
		Electrocardiogram
65–74 y	CBC	CBC
	Electrocardiogram	Electrocardiogram
	Creatinine/BUN	Creatinine/BUN
	Glucose	Glucose
>74 y	CBC	CBC
	Electrocardiogram	Electrocardiogram
	Creatinine/BUN	Creatinine/BUN
	Glucose	Glucose
	? Chest roentgenogram	? Chest roentgenogram

Note: For operative procedures with anticipated significant blood loss. coagulation testing and a CBC are appropriate in all patients.
CBC = complete blood count; BUN = blood urea nitrogen.
Source: Modified from Roizen MF, Fischer SP. Preoperative evaluation for adults and children. In: Paul White. ed. Ambulatory anesthesia and surgery. London: Saunders, 1996 (in press).

borderline or false/positive laboratory abnormalities. This may result in unnecessary operating room delays, cancellations, and potential patient risks through additional testing and follow-up.

The neurosurgical patient will require preoperative laboratory and diagnostic studies consistent with his or her medical history, the proposed operative procedure, and potential for blood loss. Table 4 summarizes the recommended preoperative tests for the neurosurgical patient.

■ Summary

The purpose of this chapter is to provide the anesthesiologist with a focused review of the information needed to rationally approach the preoperative evaluation of the neurosurgical patient. The anesthesia preoperative assessment is a neuromedical evaluation of the patient's current condition integrated with the anesthesiologist's knowledge of the potential clinical and operative events that may occur.

The neurosurgical patient presents the anesthesiologist with significant clinical challenges in providing the most appropriate care and the best

outcome possible. The foundation of this challenge begins with the anesthesia preoperative evaluation.

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