NORMAL INTRACRANIAL PRESSURE

- **Intracranial pressure** (ICP) is the hydrostatic force measured in the brain CSF compartment. Normal ICP is the total pressure exerted by the three components within the skull: brain tissue, blood, and CSF.

- If the volume of any one of the three components increases within the cranial vault and the volume from another component is displaced, the total intracranial volume will not change.

- ICP can be measured in the ventricles, subarachnoid space, subdural space, epidural space, or brain parenchymal tissue using a pressure transducer. Normal intracranial ICP ranges from 0 to 15 mm Hg.

- A sustained pressure above the upper limit is considered abnormal. ICP may rise due to head trauma, stroke, subarachnoid hemorrhage, brain tumor, inflammation, hydrocephalus, or brain tissue damage from other causes.

CRANIAL BLOOD FLOW

- **Cerebral blood flow** (CBF) is the amount of blood in milliliters passing through 100 g of brain tissue in 1 minute.

- Through a process known as *autoregulation*, the brain has the ability to regulate its own blood flow in response to its metabolic needs despite wide fluctuations in systemic arterial pressure.

- The *cerebral perfusion pressure* (CPP) is the pressure needed to ensure blood flow to the brain. As the CPP decreases, autoregulation fails and CBF decreases, which can lead to ischemia and neuronal death.

- *Compliance* is the expandability of the brain. With low compliance, small changes in volume result in greater increases in pressure.

INCREASED INTRACRANIAL PRESSURE

- Increased ICP is a life-threatening situation that results from an increase in any or all of the three components (brain tissue, blood, CSF) within the skull. **Cerebral edema** is an important factor contributing to increased ICP.

- Elevated ICP is clinically significant because it diminishes CPP, increases risks of brain ischemia and infarction, and is associated with a poor prognosis.

- The clinical manifestations of increased ICP can take many forms, depending on the cause, location, and rate at which the pressure increase occurs. Complications of ICP include changes in the level of consciousness, changes in vital signs, dilation of pupils, decrease in motor function, headache, and vomiting.

- The earlier the condition is recognized and treated, the better the patient outcome.

- The major complications of uncontrolled increased ICP are inadequate cerebral perfusion and cerebral herniation.
ICP monitoring is used to guide clinical care when the patient is at risk for or has elevations in ICP. It may be used in patients with a variety of neurologic insults, including hemorrhage, stroke, tumor, infection, or traumatic brain injury.

The “gold standard” for monitoring ICP is the ventriculostomy, in which a specialized catheter is inserted into the right lateral ventricle and coupled to an external transducer. Other devices now allow for an indirect assessment of cerebral oxygenation and perfusion.

With the ventricular catheter and certain fiberoptic systems, it is possible to control ICP by removing CSF. The level of the ICP at which to initiate drainage, amount of fluid to be drained, height of the system, and frequency of drainage are ordered by the physician.

The goals of collaborative care are to identify and treat the underlying cause of increased ICP and to support brain function.

Drug therapy plays an important part in the management of increased ICP. An osmotic diuretic, corticosteroids, and barbiturates may be prescribed.

All patients must have their nutritional needs met, regardless of their state of consciousness or health. Early feeding following brain injury may improve outcomes.

The Glasgow Coma Scale is a quick, practical, and standardized system for assessing the degree of impaired consciousness that should be used during nursing assessment. Also during assessment, the pupils are compared to one another for size, shape, movement, and reactivity.

The overall nursing goals are that the patient with increased ICP will (1) maintain a patent airway, (2) have ICP within normal limits, (3) demonstrate normal fluid and electrolyte balance, and (4) have no complications secondary to immobility and decreased level of consciousness.

Maintenance of a patent airway is critical in the patient with increased ICP and is a primary nursing responsibility. As the level of consciousness decreases, the patient is at increased risk of airway obstruction from the tongue dropping back and occluding the airway or from accumulation of secretions.

The patient with increased ICP should be maintained in the head-up position. The nurse must take care to prevent extreme neck flexion, which can cause venous obstruction and contribute to elevated ICP.

The patient with increased ICP and a decreased level of consciousness needs protection from self-injury. Confusion, agitation, and the possibility of seizures increase the risk for injury.

HEAD INJURY

Head injury includes any trauma to the scalp, skull, or brain. The term head trauma is used primarily to signify craniocerebral trauma, which includes an alteration in consciousness, no matter how brief.

Scalp lacerations are an easily recognized type of external head trauma. Because the scalp contains many blood vessels with poor constrictive abilities, the major complications associated with scalp laceration are blood loss and infection.
• **Skull fractures** frequently occur with head trauma. There are several ways to describe skull fractures: (1) linear or depressed; (2) simple, comminuted, or compound; and (3) closed or open.

• A **concussion** is a sudden transient mechanical head injury with disruption of neural activity and a change in the LOC and is considered a minor head injury.

• A **contusion**, a major head injury, is the bruising of the brain tissue within a focal area. A contusion may contain areas of hemorrhage, infarction, necrosis, and edema and frequently occurs at a fracture site.

• **Lacerations**, another major head trauma, involve actual tearing of the brain tissue and often occur in association with depressed and open fractures and penetrating injuries.

• Complications from a head injury may include an **epidural hematoma**, a **subdural hematoma**, and **intracerebral hematoma**.

• CT scan is considered the best diagnostic test to evaluate for craniocerebral trauma because it allows rapid diagnosis and intervention in the acute setting. MRI, PET, and evoked potential studies may also be used in the diagnosis and differentiation of head injuries.

• The most important aspects of nursing assessment are noting the GCS score, assessing and monitoring the neurologic status, and determining whether a CSF leak has occurred.

• The overall nursing goals are that the patient with an acute head injury will (1) maintain adequate cerebral oxygenation and perfusion; (2) remain normothermic; (3) achieve control of pain and discomfort; (4) be free from infection; and (5) attain maximal cognitive, motor, and sensory function.

• Management at the injury scene can have a significant impact on the outcome of the head injury. The general goal of acute nursing management of the head-injured patient is to maintain cerebral oxygenation and perfusion and prevent secondary cerebral ischemia.

• The major focus of nursing care for the brain-injured patient relates to increased ICP. However, there may be other specific problems that require nursing intervention, such as hyperthermia.

• Once the condition has stabilized, the patient is usually transferred for acute rehabilitation management to prepare the patient for reentry into the community. Many of the principles of nursing management of the patient with a stroke are appropriate.

**BRAIN TUMORS**

• Brain tumors can occur in any part of the brain or spinal cord. Tumors of the brain may be **primary**, arising from tissues within the brain, or **secondary**, resulting from a metastasis from a malignant neoplasm elsewhere in the body.

• Brain tumors are generally classified according to the tissue from which they arise. The most common primary brain tumors originate in astrocytes and these tumors are called gliomas.
• Unless treated, all brain tumors eventually cause death from increasing tumor volume leading to increased ICP. Brain tumors rarely metastasize outside the central nervous system (CNS) because they are contained by structural (meninges) and physiologic (blood-brain) barriers.

• Wide ranges of possible clinical manifestations are associated with brain tumors. Headache is a common problem and seizures are common in gliomas and brain metastases.

• An extensive history and a comprehensive neurologic examination must be done in the workup of a patient with a suspected brain tumor. A new onset seizure disorder may be the first indication of a brain tumor. The correct diagnosis of a brain tumor can be made by obtaining tissue for histologic study.

• Surgical removal is the preferred treatment for brain tumors. Radiation therapy is commonly used as a follow-up measure after surgery. The effectiveness of chemotherapy has been limited by difficulty getting drugs across the blood-brain barrier, tumor cell heterogeneity, and tumor cell drug resistance.

• The overall nursing goals are that the patient with a brain tumor will (1) maintain normal ICP, (2) maximize neurologic functioning, (3) achieve control of pain and discomfort, and (4) be aware of the long-term implications with respect to prognosis and cognitive and physical functioning.

• Due to behavioral instability, close supervision of activity, use of side rails, judicious use of restraints, appropriate sedative medications, padding of the rails and the area around the bed, and a calm, reassuring approach to care are all essential techniques in the care of these patients.

**CRANIAL SURGERY**

• The cause or indication for cranial surgery may be related to a brain tumor, CNS infection (e.g., abscess), vascular abnormalities, craniocerebral trauma, seizure disorder, or intractable pain.

• Stereotactic surgery uses precision apparatus (often computer-guided) to assist the surgeon to precisely target an area of the brain. Stereotactic biopsy can be performed to obtain tissue samples for histologic examination.

• *Stereotactic radiosurgery* is a procedure that involves closed-skull destruction of an intracranial target using ionizing radiation focused with the assistance of an intracranial guiding device. A sophisticated computer program is used while the patient’s head is held still in a stereotactic frame.

• Craniotomy is another cranial surgical option. Depending on the location of the pathologic condition, a craniotomy may be frontal, parietal, occipital, temporal, or a combination of any of these.

• The overall goals are that the patient with cranial surgery will (1) return to normal consciousness, (2) achieve control of pain and discomfort, (3) maximize neuromuscular functioning, and (4) be rehabilitated to maximum ability.

• The primary goal of care after cranial surgery is prevention of increased ICP. Frequent
assessment of the neurologic status of the patient is essential during the first 48 hours.

- The rehabilitative potential for a patient after cranial surgery depends on the reason for the surgery, the postoperative course, and the patient’s general state of health. Nursing interventions must be based on a realistic appraisal of these factors.

**INFLAMMATORY CONDITIONS OF THE BRAIN**

- Meningitis, encephalitis, and brain abscesses are the most common inflammatory conditions of the brain and spinal cord. Inflammation can be caused by bacteria, viruses, fungi, and chemicals.

**Bacterial Meningitis**

- **Meningitis** is an acute inflammation of the meningeal tissues surrounding the brain and the spinal cord. Bacterial meningitis is considered a medical emergency.

- Meningitis usually occurs in the fall, winter, or early spring, and is often secondary to viral respiratory disease. Older adults and persons who are debilitated are more often affected than is the general population.

- Fever, severe headache, nausea, vomiting, and **nuchal rigidity** (neck stiffness) are key signs of meningitis.

- The most common acute complication of bacterial meningitis is increased ICP. Most patients will have increased ICP, and it is the major cause of an altered mental status.

- When a patient presents with manifestations suggestive of bacterial meningitis, a blood culture should be done. Diagnosis is usually verified by doing a lumbar puncture with analysis of the CSF.

- When meningitis is suspected, antibiotic therapy is instituted after the collection of specimens for cultures, even before the diagnosis is confirmed.

- All patients suffer some degree of mental distortion and hypersensitivity and may be frightened and misinterpret the environment. Every attempt should be made to minimize environmental stimuli and prevent injury.

- Fever must be vigorously managed because it increases cerebral edema and the frequency of seizures.

- Meningitis generally requires respiratory isolation until the cultures are negative. Meningococcal meningitis is highly contagious whereas other causes of meningitis may pose a minimal to no infection risk with patient contact.

- After the acute period has passed, the patient requires several weeks of convalescence before normal activities can be resumed. In this period, adequate nutrition should be stressed, with an emphasis on a high-protein, high-calorie diet in small, frequent feedings.

**Viral Meningitis**

- The most common causes of viral meningitis are enteroviruses, arboviruses, human immunodeficiency virus, and herpes simplex virus (HSV).
• Viral meningitis usually presents as a headache, fever, photophobia, and stiff neck. There are usually no symptoms of brain involvement.

• Viral meningitis is managed symptomatically because the disease is self-limiting. Full recovery from viral meningitis is expected.

**Encephalitis**

• **Encephalitis**, an acute inflammation of the brain, is a serious, and sometimes fatal, disease.

• Encephalitis is usually caused by a virus. Many different viruses have been implicated in encephalitis, some of them associated with certain seasons of the year and endemic to certain geographic areas. Ticks and mosquitoes transmit epidemic encephalitis.

• Signs of encephalitis appear on day two or three and may vary from minimal alterations in mental status to coma. Virtually any CNS abnormality can occur, including hemiparesis, tremors, seizures, cranial nerve palsies, personality changes, memory impairment, amnesia, and dysphasia.

• Collaborative and nursing management of encephalitis, including West Nile virus infection, is symptomatic and supportive. In the initial stages of encephalitis, many patients require intensive care.

**Rabies**

• Despite the success of vaccines in domestic animals, rabies remains a serious public health concern due to the presence of the disease in wild animals. Once a human contracts rabies and develops symptoms, the disease almost always ends in death.

• Although rabies is generally transmitted via saliva from the bite of an infected animal, it can also be spread by scratches, by mucous membrane contact with infected secretions, and by inhalation of aerosolized virus into the respiratory tract. Any warm-blooded mammal can carry rabies, including livestock.

• Two presentations of rabies include encephalitic rabies, which is the most common, and paralytic rabies.

• Because rabies is nearly always fatal, management efforts are directed at preventing the transmission and onset of the disease.

**Brain Abscess**

• **Brain abscess** is an accumulation of pus within the brain tissue that can result from a local or a systemic infection. Direct extension from ear, tooth, mastoid, or sinus infection is the primary cause.

• The manifestations of brain abscess are similar to those of meningitis and encephalitis.

• Antimicrobial therapy is the primary treatment for brain abscess. Other manifestations are treated symptomatically.