Intracranial Monitoring

The value of continuous measurement of intracranial pressure (ICP) in the management of patients with certain neurosurgical disorders has been well-established but remains controversial. These conditions include: head injury, postoperative brain tumor, subarachnoid hemorrhage, cerebrovascular accident, encephalitis, hydrocephalus, and near drowning. Brain swelling and increased intracranial pressure are common in patients with acute brain injuries of many natures. The following therapeutic regimens have been developed over time to treat patients with such problems and are directed to a reduction of brain swelling and intracranial pressure. They include:

1. Hypertonic solution - Urea, mannitol, glycerol.
3. Mega dose steroids - The use of high-dose Decadron or Solu-Medrol.
4. Hypothermia with a reduction of core body temperature to 32.0 C.
5. Hyperbaric oxygen - Controversial.
6. Barbiturate coma - Controlled depression of brain function.
7. Other modalities - Reduction in activity of brain-evoked potential using drugs.

Without a continuous ICP recording, the effects of the above-noted modalities cannot be effectively monitored. Other modes of measurement of brain function include EEG, regional cerebral blood flow, oxygen extraction fraction, and brain-evoked potentials.

Techniques for management of intracranial pressure, many have developed, to monitor the pressure within the closed space of the skull. The pressures are the same regardless of the site of measurement and the various techniques that have been developed to attempt accuracy and/or convenience. At one time, the lumbar subarachnoid space (lumbar puncture) was used, but this is hazardous in the patient with increased intracranial pressure as it may precipitate cerebral and cerebellar herniation. Therefore, it is to be condemned in acute injuries and certain other conditions. All currently used devices are aimed at accuracy and minimizing potential brain damage. There are two methods at this institution to measure ICP:

1. Placement of a Richmond screw attached to a venous pressure gauge system.

There are kits now available made by Codman (disposable) and as convenient as a lumbar puncture tray. With these kits, a Richmond screw can virtually be installed on a patient on the wards, in the operating room, or emergency room. They are presently available in the operating room but will be distributed to various key areas. The screw will be placed by a physician through the scalp, usually in the right frontal forehead. Subsequently, using IV tubing primed with normal saline, the apparatus can then be attached to the venous manometer or standard bedside monitoring equipment.

When an ICP Richmond screw is to be placed, the following equipment needs to be available:

1. The ICP kit.
2. 7-1/2 sterile latex gloves.
4. Alcohol solution.
5. Intravenous tubing primed with normal saline attached for ICP monitoring.
6. Razor blades, 1” adhesive tape.

Following placement of the ICP monitor, the area is to be cleansed daily with half-strength hydrogen peroxide and Betadine ointment placed around the base of the screw and subsequently a sterile dressing. The screws are usually left in place for 72 hours and may on occasion be left longer. The danger with long-term placement of
a screw is the possibility of contamination and subsequent meningitis. Hence, if the patient requires the screw longer, it may be replaced in a new area. Dressings and connections otherwise should not be tampered with. The system should be considered closed.

II. Placement of an intraventricular catheter.

The central portion of the brain is hollow - filled with clear fluid. If a catheter were introduced into this chamber (ventricle), it could then be externalized and attached to either a drainage system or a monitoring system. A ventricular catheter has the advantage of both allowing for measurement of ICP and drainage of cerebrospinal fluid. Hence, in patients with hydrocephalus who are not candidates for a shunting procedure, then a ventricular catheter attached to a drainage system may be the procedure of choice.

The technique of catheter placements: (same equipment).

The procedure is similar to that of a Richmond screw. It is placed in the same area. The technique is the same, except that the physician has to obtain a Scott cannula or Holter catheter from the operating room. In addition, a 15-gauge blunt needle and suture material must be obtained to be able to attach the catheter to the collection system. The Cordis collection system is available in the operating room but will soon by distributed to other key areas of the hospital in order to allow for convenience in obtaining of the system for placement. Subsequently, the system can be attached either to a pressure monitor or attached for drainage.

Using aseptic technique, the physician will place a twist drill hole and insert the catheter securing it with sutures. It is incumbent upon nursing care not to pull the catheter out. The drainage back is attached as per the following diagram:

Generally, a patient with increased intracranial pressure from trauma will require removal of several amounts of cerebrospinal fluids from the ventricular catheter unit if this is the method chosen. Often 2 or 3 cc will result in a dramatic reduction of intracranial pressure. The same result can be obtained by the use of intravenous diuretics, or other drug agents that reduce increased intracranial pressure. The bedside monitor will provide readout of the pressure and the waveform with a dicrotic notch demonstrating changes in intracranial pressure should be obtained. If not, one must be concerned that the catheter is not working properly. The removal of large amounts of intraventricular cerebrospinal fluid may result in sudden death and, hence, only a small amount should be removed at a time (2-3 cc). The intracranial pressure should be recorded on the patient’s vital signs adjacent to recording of the patient’s Glasgow coma score.

The patient should be maintained with bed rest, with the head of the bed elevated as prescribed by the physician, usually 30 degrees. If the patient has an intraventricular catheter with drainage, the drip chamber should be secured in the upright position at the head of the bed using an IV pole or a ventricular drainage stand. The level of the drip chamber should be maintained at the level prescribed by the physician (usually 10-20 cm above the level of the ventricle essentially the external auditory meatus). Keep in mind that the amount of drainage is controlled entirely by the relative position of the patient’s head to the drip chamber. Excessive drainage can cause collapse of the ventricles with strain on the blood vessels resulting in massive intracerebral hemorrhage. Thus, proper position is critical. The patient may usually turn from side-to-side, but the head of the bed should not be raised or lowered. It is helpful placing a marker at the top of the patient’s head to prevent position changes due to sliding down in the bed. In addition, the bed control should be placed out of the patient’s reach or disconnected to prevent the patient from changing his or her head position. A Posey body restraint may be needed to keep the patient from sitting up.

The drainage bag may be secured at any convenient level below the level of the drip chamber. Secure the tubing to prevent kinks.
The drainage bag should be changed only when full to let drainage and the caliber of the drip chamber for 4-8 hours (or as ordered), record by color and appearance and drain into bag. When bag is full (usually not more often than every 36-48 hours), obtain a Cordis replacement drainage bag from the operating room or storage area in the ICU. Carefully disinfect the connector at the top of the drainage bag using a sterile dressing saturated with Betadine solution for at least five minutes. Using sterile gloves, disconnect the used bag and attach the other one.

Should the tubing become disconnected or leak at any point, it is considered contaminated. Clamp the drainage tube between the disconnection (or leak) and the catheter hub (under the dressing). Clean around the catheter with Betadine as described above. Using sterile gloves, disconnect the contaminated set and reconnect the new set. Reapply the dressing. Avoid leaking fluid during transit.

Check head dressing, catheter site, drainage tube, drip chamber, and drainage bag frequently to assure proper positioning and continuing drainage.

Transporting or moving the patient with an ICP monitor:

Should it become necessary to move the patient or change the position of the patient's bed relative to the drip chamber (as for CT scans), clamp the drainage tube using the small white clamp between the patient’s head and the drip chamber. The tube may remain clamped for a few minutes or longer.

Collection or cerebrospinal fluid for testing:

When a patient has a ventricular catheter in place, every two days, using sterile technique, apply Betadine to clean the connector, open the stopcock at the yellow connector below the drip chamber and collect spinal fluid for culture and sensitivity, being careful not to contaminate anything.

Intracranial pressure monitoring has not been shown to have a significant prognostic correlation. It is to help manage the patient with increased intracranial pressure, especially head injury. With a severe head injury and a patient who is comatose and decerebrate and who has a normal intracranial pressure, it is likely the lesion is primarily in the brain stem, which carries with it a serious prognosis. Intracranial pressure measurements are more accurate than vital signs in severe head injury situations. It has been found in a study in Virginia that a well-trained ICP nurse can pick up the subtle signs of neurological deterioration before intracranial pressure increases. A rise in intracranial pressure may indicate the presence of a hematoma, increasing cerebral edema, deterioration in the state of a stable intracerebral hematoma, or Intracranial Pressure Monitoring worsening of a contusion. It may also indicate that efforts to reduce intracranial pressure, i.e., hyperventilation, dehydration, etc., are failing and some other method needs to be obtained.