



Critical Care Therapy and Respiratory Care Section

Category:	Clinical
Section:	Clinical Monitoring
Title:	Intracranial Pressure Monitoring
Policy #:	04
Revised:	06/00

1.0 DESCRIPTION

1.1 Definition: The primary goals of intracranial pressure (ICP) monitoring are identification of intracranial pressure trends and evaluation of therapeutic interventions in order to minimize ischemic injury in the brain-injured patient. Intracranial hypertension (sustained ICP equal to or greater than 15 mm Hg) results when the brain's protective mechanisms to shunt cerebrospinal fluid (CSF) to the subarachnoid space or to vasoconstrict cerebral arterioles fail to maintain the ICP below 15 mm Hg. Intracranial hypertension compromises the relationship between systemic blood pressure and the resistance that must be overcome to accomplish cerebral perfusion. When cerebral perfusion pressure (CPP), calculated by subtracting the ICP from the mean arterial pressure, falls below 50 mm Hg, secondary brain ischemia, herniation, and, ultimately, brain death occur. ICP monitoring allows for early detection of intracranial hypertension and subsequent aggressive management.

ICP monitoring is accomplished by the use of a fluid-filled monitoring system attached to an intraventricular catheter. The ICP waveform resembles a dampened arterial blood pressure waveform and is considered normal when the pressure is between 0 and 15 mm Hg. In addition, a stopcock within the system allows for therapeutic drainage of CSF and for sampling for infection surveillance.

1.2 Personnel: ICP monitoring is a complex task that requires knowledge and understanding of the technical components of fluid-filled monitoring systems, the pathophysiology of the central nervous system, and the interaction between these systems. Personnel performing the setup, data collection, or maintenance procedures should hold board recognized credentials, i.e. RRT, CRT, or RN, and should have documented competency in:

1.2.1 The technical setup and operation of the pressure monitoring system

- 1.2.2 Central nervous system physiology and pathophysiology
- 1.2.3 ICP waveform analysis
- 1.2.4 Appropriate response to adverse reactions
- 1.2.5 Application of Universal Precautions

1.3 Indications May Include

- 1.3.1 Severe traumatic brain injury
- 1.3.2 Intracranial hemorrhage
- 1.3.3 Cerebral edema
- 1.3.4 Post-craniotomy
- 1.3.5 Space-occupying lesions such as epidural and subdural hematomas, tumors, abscesses, or aneurysms which occlude the CSF pathway
- 1.3.6 Reye syndrome patients who develop coma, posturing, and abnormal responses to obnoxious stimuli
- 1.3.7 Encephalopathy from lead ingestion, hypertensive crisis, or hepatic failure
- 1.3.8 Meningitis/encephalitis resulting in malabsorption of CSF

1.4 Contraindications

- 1.4.1 Central nervous system infection
- 1.4.2 Coagulation defects
- 1.4.3 Anticoagulant therapy
- 1.4.4 Scalp infection
- 1.4.5 Severe midline shift resulting in ventricular displacement
- 1.4.6 Cerebral edema resulting in ventricular collapse

1.5 Complications

- 1.5.1 Intracranial infection
- 1.5.2 Intracerebral hemorrhage
- 1.5.3 Air leakage into the ventricle or subarachnoid space
- 1.5.4 CSF leakage
- 1.5.5 Overdrainage of CSF leading to ventricular collapse and herniation
- 1.5.6 Loss of monitoring or drainage capabilities due to the occlusion of the catheter with brain tissue or blood
- 1.5.7 Inappropriate therapy because of erroneous ICP readings due to dampened waveforms, electromechanical failure, or operator error (i.e. inappropriate leveling)

1.6 Precautions

- 1.6.1 To minimize the risk of central nervous system infection, aseptic technique must be used at all times when assembling, manipulating, or accessing the fluid-filled monitoring system.
- 1.6.2 Tight connections must be maintained, and the system must remain free of air to ensure maximal accuracy.
- 1.6.3 **Never** use a flush device for ICP monitoring. Use only sterile 0.9% NaCl to fill the pressure tubing. **Never** use a heparinized solution.
- 1.6.4 To ensure optimal accuracy, proper leveling and zeroing of the system must be maintained. The proper level for the transducer is at the foramen of Monro measured at the level of the outer canthus of the eye, or alternatively, at the spine for lumbar drainage.
- 1.6.5 Utmost care must be taken when positioning and turning the patient to avoid accidental decannulation or disconnection of the tubing.
- 1.6.6 Patients are maintained in a 30 to 45 degree head up and neutral position when necessary to minimize the ICP. Use extreme caution when positioning patients and performing therapy so as to minimize increases in ICP and associated degradations in CPP. Avoid flexion and hyperextension of the neck and positioning the patient in a Trendelenberg position, all of which may increase ICP.

NOTE: An alarm for high ICP must be maintained ON at all times.

- 1.6.7 Use care when manipulating the drainage system to avoid getting the filter wet. The drainage cylinder should remain in an upright position at all times. If the filter should get wet, and drainage is slowed or stopped, some time may be required for the filter to dry out sufficiently before adequate drainage is reestablished.
- 1.6.8 The *Cordis EDS* and pressure transducer systems are intended for single-patient use only. Do not sterilize any part of the disposable system for reuse.
- 1.6.9 Simultaneous drainage and pressure monitoring is not recommended. To ensure precise pressure measurements, perform only pressure monitoring while keeping the stopcock closed to the drainage system.
- 1.6.10 Only a small amount of CSF (approximately two ml) should be drained a one time. Rapid cerebral decompression from CSF overdrainage may result in herniation. Overdrainage may occur if the system is inadvertently left open, or if the patient is maintained at a higher level than the reference point on the system (as per physician order). **NOTE:** The height of the drainage cylinder determines the rapidity at which CSF will drain. The physician's order for drainage must include a pressure reading in either mm Hg or cm H₂O at which height (as marked on the mounting card) the drainage cylinder must be maintained. The zero reference point for ICP monitoring always remains the outer canthus of the eye (or for lumbar drainage, the spine).

1.7 Adverse Reactions and Interventions

- 1.7.1 If blood is visualized in the pressure tubing (from intracranial hemorrhage), notify the physician.
- 1.7.2 If a good waveform and/or accurate ICP cannot be obtained, a flush of the fluid-filled monitoring system (with sterile 0.9% NaCl) may be attempted. All connections should first be checked for tightness. **Never** flush the system while it is open to the patient. Close the stopcock to the patient and then attempt to flush the monitoring system. Resume pressure monitoring by opening the system to the patient. If a poor waveform persists, troubleshoot the system as you would any other including debubbling, releveling and zeroing, and changing the electrical cable. If all of these maneuvers fail to correct the poor waveform, notify the physician.

The catheter may be occluded with blood or tissue requiring physician intervention. **NOTE:** An acutely low ICP may be indicative of acute decompression due to leakage or overdrainage of CSF. Notify the physician and nurse immediately.

- 1.7.3 In case of acute decompensation (i.e. sustained ICP greater than or equal to 15 mm Hg), be prepared to hyperventilate the patient with a manual resuscitator connected to 100% oxygen. Notify the physician and/or nurse.
- 1.7.4 If the patient shows signs of decompensation including altered level of consciousness, restlessness, agitation, lethargy, confusion, motor weakness, seizures, alteration in breathing pattern, increases in blood pressure, bradycardia, vomiting, decortication/decerebration, or coma, notify the nurse and physician immediately.

2.0 EQUIPMENT

- 2.1 Cordis EDS with mounting card
- 2.2 Pressure transducer with 48-inch pressure tubing
- 2.3 Sterile 0.9% NaCl with sterile 20-ml syringe
- 2.4 Pressure monitoring cable
- 2.5 Intravenous cable
- 2.6 Manual resuscitator, mask, and 100% oxygen source
- 2.7 Cardiopulmonary monitor
- 2.8 Universal precautions attire

3.0 PROCEDURE

- 3.1 Assemble the Cordis EDS as instructed per the package insert (reprinted at the end of this procedure) and per the mounting card diagrammatic instructions using 0.9% NaCl to flush the system. Place the 48-inch tubing with connected pressure transducer on the plastic mounting card.
- 3.2 Place the patient in a semi-Fowler's position and position the zero reference point at the outer canthus of the eye.

- 3.3 Obtain the ICP pressure waveform on the cardiopulmonary monitor. Turn the stopcock nearest to the patient so that the ICP waveform is visualized. Zero the transducer at the distal stopcock.
- 3.4 Record the ICP on the printer and mark and post the strip. Calculate and record the CPP on the strip.
- 3.5 For continuous drainage, turn the stopcock nearest to the patient so that drainage resumes and pressure monitoring is discontinued. **NOTE:** It is recommended that pressure monitoring and CSF drainage not be done simultaneously.

4.0 POST PROCEDURE AND DOCUMENTATION

- 4.1 Ensure that all connections are tight, and that the drainage system is positioned at the precise height for drainage according to the physician's order before leaving the bedside.
- 4.2 Relevel and zero the system every four hours and as needed.
- 4.3 Change the transducer and pressure tubing every 72 hours as per the CCTRCS Changing of Equipment Policy.
- 4.4 Post a strip of the ICP in the patient's bedside chart at least once per shift, and record that ICP on the bedside nursing flowsheet. It is probable that nursing will measure ICP much more frequently. Each posted strip should also have documentation of the corresponding CPP.
- 4.5 Record changes to the transducer and flush system on the CCTRCS line board.
- 4.6 Record ICP and CPP on the CCTRCS Patient Daily Sheet. Communicate any pertinent changes in patient status to the oncoming CCTRCS staff.

5.0 REFERENCES

- 5.1 Ropper AH, Kennedy SF, eds. Neurological and neurosurgical intensive care. Rockville, MD: Aspen Publishers, 1988.
- 5.2 Boggs RL, Wooldridge-King M, eds. Intracranial pressure monitoring. In: AACN procedure manual for critical care. Philadelphia: WB Saunders, 1993.

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