Title: Intracranial Pressure (ICP) Monitoring and External Ventricular Drains: Adult and Pediatric

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Cross-Referenced Policy No: See Lippincott Williams & Wilkins- Ventricular drain insertion, assisting, and pediatric procedures.

I. POLICY:

1. A pressure bag is never used with the fluid-filled transducer.
2. Patients with EVD and/or ICP monitoring will be monitored in an Intensive Care Setting.
3. EVD/ICP is placed by the neurosurgeon in the OR, ER or ICU bedside under sterile conditions. All pediatric patients will utilize the drainage limiting device system unless specified by the neurosurgeon.
4. The neurosurgeon will prescribe height of drainage system; hourly drainage amount; and intermittent versus continuous drainage. Parameters for ICP may also be prescribed.
5. Aspiration or irrigation of a ventricular catheter is only done by the neurosurgical team or trained intensivist.
6. EVD system is a closed sterile system. The transducer and drip chamber are not changed, unless broken or clogged. Nurses may change the drainage bag on the drainage system when approximately ¾ full under sterile technique. Discard the full bag into biohazard waste if there’s blood in the drainage.
7. Routine dressing changes are done by the neurosurgical team. If the dressing is soiled or off, then the RN may change it under sterile technique. The nurse may reinforce or apply dry sterile dressing to maintain catheter placement and insertion site sterility.
8. ICP monitoring may be done using fiber optic catheter (Camino) or fluid filled transducer as prescribed by neurosurgical team.
9. Amount of CSF drainage may be significantly impacted by the following: sudden change in position (up, down, side to side) in relation to drainage system, during transportation, or noxious procedures during suctioning. This may require adjustment in height of drain or temporary clamping of system. Obtain an LIP order to adjust the height of the drain or clamping of the system.
10. ICP and CSF drainage are monitored hourly (at a minimum) or as directed by p LIP orders and recorded.
11. All patients with EVDs should be prescribed anti-microbial therapy and CSF replacement (commonly NS, cc/cc replacement for CSF output).
12. Vitals signs will be every one to two hours for all patients with an EVD and/or ICP until EVD or ICP is discontinued. EVD output is monitored hourly.

II. PURPOSE:

To outline the insertion, maintenance and care of the patient with an external ventricular drain and/or intracranial monitoring.

III. DEFINITIONS:

- **Cerebral Spinal Fluid (CSF)** is a clear fluid that is produced by the choroid plexus of the ventricular system. CSF bathes the brain and the spinal cord providing a cushion that helps prevent injury. CSF is produced at a rate of 20ml/h in children and 20-30 ml/hour in adults.

- **Hydrocephalus** “hydro” meaning water, “cephalus” meaning head. A condition resulting from an imbalance between the production and absorption of CSF which results in an increased volume of spinal fluid, dilation of the ventricular system, and often increased intracranial pressure.

- **External Ventricular Drain (EVD)** is a closed sterile system that allows the CSF to drain into a sliding graduated flow chamber that can be adjusted to a prescribed level. An EVD is a drain that is inserted into the ventricle through a ventriculostomy or an externalization of an existing shunt. The purpose is to control ICP and drain CSF.

- **Intracranial Pressure (ICP)** is the total pressure exerted by the blood, brain, and CSF in the intracranial vault.

- **Normal ICP measurements:**
  - Infant: 1 to 8 mm Hg;
  - Young child: 3 to 10 mm Hg;
  - Older child/adult: 1 to 15 mm Hg.

- **Intracranial ICP Hypertension:**
  - Child: greater than or equal to 18 mm Hg for more than 5 minutes.
  - Adult: greater than or equal to 20 mm Hg for more than 5 minutes.

- **Severe Intracranial ICP Hypertension**
  - ICP greater than or equal to 25.

- **Cerebral Perfusion Pressure (CPP)** is an indirect measurement of cerebral blood flow calculated by measuring the difference between the mean arterial pressure (MAP) and ICP. **CPP = MAP-ICP.** CPP must be maintained above a certain value to prevent cerebral ischemia. **CPP accepted normal values:** infants/toddlers: >40-50mm Hg; children: >50-60mm Hg; adults : > 70mm Hg.

- **Foramen of Monro** is at the external auditory meatus on a supine child.
IV. **EDUCATION:**

1. Provide information to the family and patient on CSF, external ventricular drain and/or intracranial monitoring.
2. Explain to the family and patient the importance of notifying a RN before adjusting the patient’s position.
3. Explain the importance of preventing disconnection of the external ventricular drain.
5. Provide information on signs and symptoms of CNS infection & increased ICP.

V. **DOCUMENTATION:**

1. Patient’s baseline neurological assessment & developmental level.
2. Hourly neurological assessment. Neurological assessment should include: Glasgow Coma Scale & pupil size and reflex.
4. Hourly CSF drainage.
5. Hourly ICP readings and CPP
6. Document level of transducer (EVD)
7. Document if EVD drainage is to be monitored intermittent or continuous.
8. Color and consistency of CSF drainage.
9. Head dressing, suture site, EVD site, bolt site assessment.
10. Change in neurological status- notification of Licensed Independent Practitioner (LIP), follow up intervention, response to intervention.
11. Abnormal ICP and CPP, notification of LIP, follow-up intervention, response to intervention
13. Patient and family response to education.

VI. **PROCEDURE:**

**Management of an EVD and ICP:**

**A. Ventriculostomy/Fluid-filled transducer – ICP monitor set up:**

- Do not use a pressure bag with the fluid-filled transducer.
- Strict Sterile Technique.
- Clean table top with antibacterial wipes and allow to dry.
- Open sterile towel.
- Place a 10 ml syringe, blunt tip, 10 ml NSS vial, disposable transducer, and three caps on sterile towel.
- Don mask and sterile gloves.
- Fill 10 ml syringe with normal saline solution from vial.
- Remove line that goes to IV bag and replace with Luer access cap.
- Attach fluid filled syringe and prime transducer tubing.
- Connect transducer tubing to the port closest to the patient on the intracranial catheter tubing.
• Clean port with betadine prior to attaching new sterile bag.
• Attach monometer to IV pole.
• Slide drip chamber onto manometer and align the chamber to the zero point.
• Attach transducer to monitor.
• Align zero point to tragus (middle of the ear) and zero the ICP transducer as per protocol.
• Adjust flow chamber height according to the physician order.
• Return stopcock to ordered position (open or closed).

B. Leveling and Zeroing:
• Measure EVD transducer to level of tragus with laser or ruler.
• Zero ICP monitor.
• After leveling transducer turn blue clamp on transducer off towards the patient- open cap to air.
• Press “zero” on the bedside monitor
• Once monitor reads zero turn blue clamp back to appropriate position.

C. Changing the CSF collection bag:
• The CSF collection bag should be changed when it is ¾ full.
1. Supplies Needed:
   • New CSF drainage bag
   • Betadine swabs
   • Sterile gloves
   • Mask (surgical)
   • Sterile towel
2. Changing the CSF collection bag:
   • Wash hands.
   • Clamp EVD off to patient.
   • Set up supplies on sterile field.
   • Don sterile gloves and mask.
   • Remove old/full drainage bag.
   • Clean connection site with betadine swabs and allow betadine to dry for 3 minutes.
   • Connect new drainage bag, verify that bag is secure.
   • Unclamp EVD.
   • Dispose of old/full drainage bag in medical waste bin.
   • Remove gloves and wash hands.

D. Assessment of patient:
• Assess baseline neurological status and developmental level.
• Assess insertion site for any signs or symptoms of infection. Signs and symptoms of infection include: Redness, drainage, blood, purulence, edema, fever, increased WBC count, CSF cultures, device cultures, or odor.
• Assess dressing at insertion site: dressing should be clean, dry and intact, occlusive. The dressing should only cover the insertion site and immediate tubing that follows majority of ventricular catheter.
- Assess that the EVD is at the ordered height in cm above the zero point of the foramen of Monroe.
- Inspect tubing for kinks, bend, unclamped, and loose connections: there should be no tension pulling the tubing down or away.
- Inspect for leaks or air bubbles in tubing.
- Inspect CSF in tubing and drip chamber for color and clarity.
- Assess for changes in patient’s neurological status from baseline including:
  a. altered, decreased LOC,
  b. anxiety,
  c. confusion,
  d. restlessness,
  e. drowsiness,
  f. diaphoresis,
  g. irritability, agitation
  h. headaches,
  i. nausea
  j. seizures,
  k. posturing,
  l. inappropriate motor function or dysfunction,
  m. widened pulse pressure,
  n. bradycardia,
  o. tachycardia
  p. altered respiratory pattern,
  q. pupillary dysfunction,
  r. nuchal rigidity and photophobia.
- Note: for infants also assess, in addition to neurological changes for child,
  o tense or bulging fontanels,
  o separated cranial sutures,
  o increased head circumference,
  o projectile vomiting,
  o high-pitched “neuro” cry,
  o paralysis of upward gaze of the eyes (sunset eyes)

E. Monitoring:
- Obtain baseline vital signs and neurological check.
- Neurological checks and Vital Signs every 1-2 hours. Age appropriate alarms parameters should be set for vital signs.
- CSF output, color and consistency every 1 hour. Check parameters for target/max drainage per neurosurgery.
- Pain assessment per hospital protocol.
- For ICP monitored patients: Note and record ICP and CPP a minimum of every 1 hour.
- Alarm parameters should be set for all patients with ICP monitoring.
- Check for integrity and sterility of the intracranial or intraventricular catheter every 1 hour and with change of position.
- Ensure that transducer is maintained at prescribed level of the foramen of Monroe.
• Zero the external transducer once a shift and after change in position of a child.

F. Safety

1. Activity/HOB/Positioning:
   • Maintain good body alignment.
   • Avoid neck flexion, extension, misalignment, head rotation.
   • Extreme knee/hip flexion can increase intra-abdominal pressure and restrict movement of diaphragm and respiratory effort.
   • Avoid Valsalva maneuvers, isometric muscle contraction, and Trendelenberg position.
   • Electric bed – engage patient lockouts for head of bed and up/down.
   • Position the EVD system on a secure IV pole next to the head of the bed. The drip chamber of the EVD should be visible at all times.
   • Instruct family/visitors to notify nursing prior to any repositioning of patient or getting out of bed.

2. Traveling/Repositioning/Suctioning:
   • Secure tubing: NEVER secure catheter to bed or side rail.
   • Clamp EVD during suctioning, repositioning, movement out of bed.
   • Unclamp immediately after process is completed or if patient has change in neurological status

3. System:
   • Do NOT change EVD monitoring system once it is in place.
   • EVD system should not be disconnected from the patient unless it is necessary to change the standard system to a drainage limiting system or if the system becomes unsterile or broken.
   • Maintain a closed sterile EVD system with minimal interruption of integrity.
   • Change collection bag with aseptic technique when it is ¾ full.

G. Reportable Conditions - Notify MD or APN if there is:
   • Any change in neurological status -- refer to above patient assessment.
   • Elevated ICP or as prescribed by neurosurgery team.
     o See troubleshooting -- then report if there is an increase ICP.
   • Unable to maintain CPP.
   • Leakage of CSF around catheter.
   • If EVD system becomes contaminated.
   • If EVD is dislodged/ disconnected- see troubleshooting and then report condition.
   • Change in color of CSF- i.e. bloody, increase in particles.
   • A sudden increase (over drainage) in the amount of CSF in the drip chamber.
   • A decrease (under drainage) in the amount of CSF in drip chamber.
     o After 1 hour of under drainage, see troubleshooting.
     o After hour 2 of under drainage, report condition.
   • Change in color of CSF drainage in drip chamber.
H. Troubleshooting:

- If the occlusive dressing over the EVD insertion site is loose or soiled, a Registered Nurse (RN) should change dressing with aseptic technique.
- If the EVD system is accidentally disconnected, clamp the ventricular catheter immediately, place the child in a supine position until the catheter is reconnected with aseptic technique. NOTE: Do not use unprotected metal clamp on catheter as it will puncture the catheter. Report condition.
- If there is no drainage in the system after 1 hour- check EVD system for patency. Observe CSF for oscillation in the tubing- if no oscillation, briefly drop the drip chamber below the level of the foramen of Monro to assess if CSF in chamber this is done under direct observation, do not leave patient’s bedside. If patency not identified, report condition.
- For sudden change in ICP, check ICP waveform for change. Zero ICP system. If unable to rectify problem, report condition.

VII. REFERENCES:


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