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## 1. PURPOSE

The MicroSensor is a device utilized for continuous measurement of intracranial pressure (ICP). An intraventricular catheter with an external transducer is used to monitor ICP and, in the presence of pathology, to alleviate increased ICP by draining cerebrospinal fluid (CSF) from the ventricular system.

## 2. POLICY STATEMENT

Registered nurses (RNs) who have met the educational and competency requirements will be able to set-up, assist with insertion, maintain ICP monitoring, manage the site, understand CSF drainage techniques, flush drainage system, and obtain CSF samples. Orders for CSF drainage must be provided by the neurosurgeon. Intraventricular catheters and/or microsensors will not be inserted in the Emergency Department.

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## INTRACRANIAL BOLT AND MICROSENSOR CATHETER INSERTION (ASSIST)

### Equipment

- Antiseptic solution (e.g., Povidone-iodine 10% solution)
- Local anaesthetic (lidocaine 1% or 2% without epinephrine), 5 mL or 10 mL Luer-Lok syringe with 18-gauge blunt needle (for drawing up lidocaine), and 25-gauge needle (for administration of lidocaine)
- Sterile water 10 mL (used for zeroing)
- Sterile gloves, surgical bouffant, procedural masks, face shields, and sterile surgical gowns
- Clippers to complete shave preparation
- Medtronic Ventriculostomy Kit (46154)
- Codman MicroSensor Skull Bolt Kit (626638)
- Codman ICP monitor with connector cable
- Monitoring cable to connect to bedside monitor
- Hypoallergenic occlusive dressing (physician dependent)

### 3. PROCEDURE

1. Obtain baseline neurological assessment and vital signs. Explain procedure to patient and family member(s) if indicated, assemble equipment and perform hand hygiene.
2. Ensure all cables are connected to the Codman ICP monitor securely. Turn Codman ICP monitoring unit on, using the ON/OFF key on front panel and wait for the screen to prompt you with instructions.
3. Connect the patient bedside monitor interface cable (located on the back of the Codman ICP monitor) into an invasive pressure module; ensure the screen is labelled ICP. Once connected, the Codman ICP monitor screen will prompt you to zero the bedside monitor. Proceed by pressing the “zero all” icon on the main screen of the bedside monitor or the “zero” icon in the ICP parameter. Either process will zero the bedside monitor. Verify that the bedside monitor displays "0" then press the "Menu/Enter" key on the Codman ICP monitor.
4. Calibrate the patient bedside monitor and Codman ICP monitor by pressing the "20" key, labelled "Calibrate Patient Monitor". The “20” key is preferred over the “100” key, as ICP pressure scale is between 0 to 40 mm Hg and this provides the best waveform scale (the “100” key is best suited with a pressure scale between 0 to 120 mm Hg). During the calibration process verify that the bedside monitor reaches 20 then returns to 0 baseline. When calibration is complete press the "Menu/Enter" key on the Codman ICP monitor.
5. Assist physician with shave and skin prep. Provide sterile materials and assistance as required. All staff assisting and/or observing the procedure must wear a procedural mask, face shield, and non-sterile gloves.
6. Provide physician with sterile ICP MicroSensor with and the sterile water for zeroing. Physician will hand end of microsensor to the assistant. Connect to the Codman MicroSensor cable, a message “Press Zero to Zero Transducer” will appear. **The microsensor must be zeroed prior to insertion.**
7. Using sterile technique the physician will place the MicroSensor tip in sterile water in the insertion tray. Assistant will press "Zero" key labelled "Zero Transducer". A random reference number will be displayed on the Codman screen. You **MUST** record this reference number on the end of the microsensor connector and the patient's plan of care (Kardex). Once number is recorded, press the Menu/Enter key. The MicroSensor is now ready for insertion.
8. After the physician inserts the MicroSensor, a numeric ICP reading will be displayed on the screen of the Codman ICP monitor. If connected to the patient's bedside monitor, an ICP waveform and numeric value is displayed on the patient's bedside monitor. The numeric value will correspond to the Codman

ICP monitor. Having a continuous ICP reading and waveform on the patient's bedside monitor allows for automatic cerebral perfusion pressure (CPP) calculation, waveform assessment, and alarm functions.

9. Once MicroSensor is secured in place, cleanse around insertion site with antiseptic solution and apply an occlusive dressing (physician preference).
10. Obtain and document the initial ICP reading once continuous monitoring is established. If connected to patient bedside monitor, assess ICP waveform morphology and obtain tracing of ICP waveform for chart. Mount a strip every shift and as required on the Monitoring Strips (CS-372) form.
11. Discard disposable supplies and sharps in appropriate receptacle.
12. Perform a post procedure neurological assessment including Glasgow Coma Scale (GCS) and vital signs to compare with the pre-procedure baseline.
13. Set the monitor alarms.
14. If the patient is being transferred, disconnect the Codman monitor from the MicroSensor during transfer to prevent unintentional dislodgement.

### **Reconnecting MicroSensor To Codman ICP and Bedside**

1. Reconnect MicroSensor to Codman ICP cable. If interfacing with patient's bedside monitor; follow steps #3 and #4 of section "A". The Codman ICP monitor will prompt user to zero bedside monitor and/or accept microsensor's reference number.
2. The Codman ICP monitor will prompt user to "accept" or "adjust" the reference number. If the reference number is correct; press "accept" and then "Menu/Entry" key. If incorrect adjust number(s) using arrow keys on the Codman ICP monitor screen then press "Menu/Enter" key. Reference number is now updated in the Codman monitor cable memory.

### **COMBINATION INTRAVENTRICULAR/MICROSENSOR CATHETER INSERTION**

#### **Equipment**

- Antiseptic solution (e.g., Povidone-iodine 10% solution
- Local anaesthetic (lidocaine 1% or 2% without epinephrine), 5 mL or 10 mL Luer-Lok syringe with 18-gauge blunt needle (for drawing up lidocaine), and 25-gauge needle (for administration of lidocaine)
- Hypoallergenic occlusive dressing (physician dependent)
- Sterile water 10 mL (used for zeroing)
- 10 mL pre-filled 0.9% NS syringe
- Sterile gloves, surgical bouffant, procedural masks, face shields, and sterile surgical gowns
- Clippers to complete shave preparation
- Medtronic Ventriculostomy Kit (46154)
- Codman MicroSensor Ventricular Catheter Kit with ICP Sensor (626653)
- Codman ICP monitor with connector cable
- Monitoring cable to connect to bedside monitor
- Medtronic External Ventricular Drainage System (46914)
- Medtronic Laser Level Laser Level

#### **Procedure**

1. Obtain baseline neurological assessment and vital signs. Explain procedure to patient and family member(s) if indicated, assemble equipment and perform hand hygiene.

2. Attach external ventricular drainage system to an intravenous (IV) pole. Ensure that all connections on the ventricular drainage system are tightened. Attach laser level.
3. Prime the external ventricular drainage system before patient attachment with 10 mL pre-filled 0.9% NS syringe. Turn the stopcocks as needed to prime the entire system.
4. Ensure all cables are connected to the Codman ICP monitor securely. Turn Codman ICP monitoring unit on, using the ON/OFF key on front panel and wait for the screen to prompt you with instructions.
5. Connect the patient bedside monitor interface cable (located on the back of the Codman ICP monitor) into an invasive pressure module; ensure the screen is labelled ICP. Once connected, the Codman ICP monitor screen will prompt you to zero the bedside monitor. Proceed by pressing the "zero all" icon on the main screen of the bedside monitor or the "zero" icon in the ICP parameter. Either process will zero the bedside monitor. Verify that the bedside monitor displays "0" then press the "Menu/Enter" key on the Codman ICP monitor.
6. Calibrate the patient bedside monitor and Codman ICP monitor by pressing the "20" key, labelled "Calibrate Patient Monitor". The "20" key is preferred over the "100" key, as ICP pressure scale is between 0 to 40 mm Hg and this provides the best waveform scale (the "100" key is best suited with a pressure scale between 0 to 120 mm Hg). During the calibration process verify that the bedside monitor reaches 20 then returns to 0 baseline. When calibration is complete press the "Menu/Enter" key on the Codman ICP monitor.
7. Assist physician with shave and skin prep. Provide sterile materials and assistance as required. All staff assisting and/or observing the procedure must wear a procedural mask, face shield, and non-sterile gloves.
8. Provide physician with sterile ICP MicroSensor/intraventricular catheter with and the sterile water for zeroing. Physician will hand end of MicroSensor to the assistant. Connect to the Codman microsensor cable, a message "Press Zero to Zero Transducer" will appear. The MicroSensor must be zeroed prior to insertion.
9. Using sterile technique the physician will place the MicroSensor/intraventricular catheter tip in sterile water in the insertion tray. Assistant will press "Zero" key labelled "Zero Transducer". A random reference number will be displayed on the Codman screen. You **MUST** record this reference number on the end of the MicroSensor connector and the patient's plan of care (Kardex). Once number is recorded, press the Menu/Enter key. The MicroSensor/intraventricular catheter is now ready for insertion.
10. After the physician inserts the MicroSensor/intraventricular catheter, a numeric ICP reading will be displayed on the screen of the Codman ICP monitor. If connected to the patient's bedside monitor, an ICP waveform and numeric value is displayed on the patient's bedside monitor. The numeric value will correspond to the Codman ICP monitor. Having a continuous ICP reading and waveform on the patient's bedside monitor allows for automatic cerebral perfusion pressure (CPP) calculation, waveform assessment, and alarm functions.
11. Once MicroSensor/intraventricular catheter is secured in place, cleanse around insertion site with antiseptic solution and apply an occlusive dressing (physician preference).
12. Attach the external ventricular drainage device to the intraventricular catheter. Slide the drip chamber reference to ordered height (either cm H<sub>2</sub>O or mm Hg) and then level with the Foramen Monroe (tragus of ear) (see Figure 1). Ensure that all stopcocks are in the appropriate position.

13. Obtain and document the initial ICP reading once continuous monitoring is established. Assess ICP waveform morphology and obtain tracing of ICP waveform for chart. Mount a strip every shift and as required on the Monitoring Strips (CS-372) form.
14. Discard disposable supplies and sharps in appropriate receptacle.
15. Perform a post procedure neurological assessment including Glasgow Coma Scale (GCS) and vital signs to compare with the pre-procedure baseline.
16. Set the monitor alarms.
17. If the patient is being transferred, disconnect the Codman monitor from the MicroSensor during transfer to prevent unintentional dislodgement. Do not disconnect external ventricular draining system for transfers.

### **Reconnecting MicroSensor To Codman ICP and Bedside**

1. Reconnect MicroSensor to Codman ICP cable. If interfacing with patient's bedside monitor; follow steps #3 and #4 of section "A". The Codman ICP monitor will prompt user to zero bedside monitor and/or accept microsensor's reference number.
2. The Codman ICP monitor will prompt user to "accept" or "adjust" the reference number. If the reference number is correct; press "accept" and then "Menu/Entry" key. If incorrect adjust number(s) using arrow keys on the Codman ICP monitor screen then press "Menu/Enter" key. Reference number is now updated in the Codman monitor cable memory.

## **INTRAVENTRICULAR CATHETER WITH/WITHOUT EXTERNAL TRANSDUCER FOR CSF DRAINAGE AND INTERMITTENT ICP MONITORING**

### **Equipment**

- Antiseptic solution (e.g., Povidone-iodine 10% solution
- Local anaesthetic (lidocaine 1% or 2% without epinephrine), 5 mL or 10 mL Luer-Lok syringe with 18-gauge blunt needle (for drawing up lidocaine), and 25-gauge needle (for administration of lidocaine)
- Hypoallergenic occlusive dressing (physician dependent)
- 10 mL pre-filled 0.9% NS syringe
- Sterile gloves, surgical bouffant, procedural masks, face shields, and sterile surgical gowns
- Clippers to complete shave preparation
- Medtronic Ventriculostomy Kit (46154)
- Codman External Drainage Ventricular Catheter (82-1705)
- Medtronic External Ventricular Drainage System (46914)
- Medtronic Laser Level Laser Level

### **Procedure**

1. Obtain baseline neurological assessment and vital signs. Explain procedure to patient and family member(s) if indicated, assemble equipment and perform hand hygiene.
2. Attach external ventricular drainage system to an intravenous (IV) pole. Ensure that all connections on the ventricular drainage system are tightened. Attach laser level.
3. Prime the external ventricular drainage system before patient attachment with 10 mL pre-filled 0.9% NS syringe. Turn the stopcocks as needed to prime the entire system.

4. Assist physician with shave and skin prep. Provide sterile materials and assistance as required. All staff assisting and/or observing the procedure must wear a procedural mask, face shield, and non-sterile gloves.
5. Once intraventricular catheter is secured in place, cleanse around insertion site with antiseptic solution and apply an occlusive dressing (physician preference).
6. Attach the external ventricular drainage device to the intraventricular catheter. Slide the drip chamber reference to ordered height (either cm H<sub>2</sub>O or mm Hg) and then level with the Foramen Monroe (tragus of ear) (see Figure 1). Ensure that all stopcocks are in the appropriate position.
7. Discard disposable supplies and sharps in appropriate receptacle.
8. Perform a post procedure neurological assessment including Glasgow Coma Scale (GCS) and vital signs to compare with the pre-procedure baseline.

### **Set-up External Transducer for Intermittent ICP Monitoring**

The physician may order intermittent ICP monitoring when using the external ventricular drainage system. Turn stopcock on external ventricular drainage system to record the ICP value. Do not leave the system open (i.e., simultaneous ICP monitoring and drainage) as the ICP is not accurate.

#### **Equipment**

- Pressure monitoring set with non-vented caps
- 10 mL pre-filled 0.9% NS syringe
- Pressure cable

#### **Procedure**

1. Remove all tubing from pressure monitoring set (only transducer is required).
2. Luer the 10 mL pre-filled 0.9% NS syringe to the female end of the transducer. Pull pig-tail and prime transducer and then turn stopcock to flush sample port.
3. Replace vented cap on sample port with non-vented cap. Turn stopcock off to male-end, removed syringe and apply a non-vented cap to female end of transducer (prevent leakage of NS).
4. Remove non-vented cap from external ventricular system and attach transducer.
5. Connect pressure cable and label pressure parameter as "ICP".
6. Zero the transducer by turning the stopcock off to the patient. Remove the non-vented cap from the stopcock, opening the stopcock to air. Press the zeroing button on the bedside monitor. Observe the digital reading unit it displays a value of zero and an audible chime. Replace the non-vented cap on the stopcock and turn the stopcock so that it is open to the transducer.
7. Set the appropriate scale for the measured pressure.
8. Set the monitor alarms limits for ICP and cerebral perfusion pressure (CPP).

## FLUSHING THE EXTERNAL VENTRICULAR DRAINAGE SYSTEM TO MAINTAIN PATENCY

### Equipment:

- Non-sterile gloves
- Chlorhexidine gluconate 2% and Isopropyl alcohol 70% swab x 2
- 10 mL pre-filled 0.9% NS syringe
- Blue clamps as required

### Procedure:

1. Gather supplies and perform hand hygiene.
2. **Obtain a second RN** (who has met the education and competency requirements of intracranial catheter management) to check proper stopcock position and that you are off to the patient connection and flushing away from the patient into the drip chamber.
3. Apply gloves.
4. Turn “patient stopcock” off to the patient.
5. Cleanse needle-free sampling port with chlorhexidine gluconate 2% and Isopropyl swab for 30 seconds and allow to dry. Attach 10 mL pre-filled 0.9% NS syringe to needle-free sampling port of the external ventricular drainage system and proceed to flush through to the drip chamber.
6. Once line is free of air/clots. Remove syringe and discard. Return stopcocks to appropriate position (either monitoring/draining). Ensure ICP waveform and numerical value return.
7. Repeat procedure as necessary to clear air/clot. If unable to clear air/clot notify neurosurgeon.
  - ★ **Note:** If a clot or air is trapped between the “patient stopcock” and the “sampling port” a blue clamp is required to clamp the patient connection line as a second clamp. The “patient stopcock” will be off to the patient and the blue clamp will be on the patient connection tubing. Attach 10 mL pre-filled 0.9% NS syringe to the port on “patient stopcock” and flush toward drip chamber. This ensures nothing is flushed into the ventricle

## PATIENT MONITORING AND CARE

1. Ensure connections are secure and there are no kinks in the tubing or catheter.
2. Change dressing as per physician’s order.
3. Ensure stopcocks to external drainage system are in the correct position and the drip chamber is at the ordered height.
4. Ensure that the “0” point of the external ventricular drainage system and the disposable transducer is maintained at the level of the Foramen of Monro (tragus of the patient’s ear). Re-adjust if the patient’s position changes. Post signs not to adjust head of bed or lock head of bed at fixed level, if required.
5. If patient is going for any diagnostic tests that require the head of bed to be frequently adjusted or flat (e.g., CT scan) clarify with physician if system should be clamped during procedure.
  - ★ **WARNING: Lowering the drip chamber increases the amount of CSF drainage. Elevating the drip chamber too high or inverting it, may allow backflow of CSF or air, obstruct drainage and alter pressure settings.**
6. Monitor ICP and CPP numeric values and ICP waveform continuously or intermittently as prescribed. Monitor CSF drainage, amount, colour, and clarity.

7. If using disposable transducer/external ventricular drainage system, level and zero to the tragus of the patient's ear at beginning of each shift. Check level every hour and more frequently as indicated.
8. The "drip chamber stopcock" controls whether CSF fluid flows through into the collection bag or accumulates into the drip chamber. It also provides for taking a sample of CSF. Ensure this stopcock is positioned appropriately to the situation (i.e., for increased ICP drainage collect in the chamber, or temporary catheter for replacement of shunt may need to flow into the collection bag).
9. Never empty the main collection bag. When collection bag is half to three quarters full, replace it with a new bag using sterile technique.
10. When intracranial catheter discontinued. Remove laser levelling device (cleanse with germicidal disposable swab) and return to storage area. Laser leveling device is not disposable.
11. Verify bedside alarm limits at the beginning of shift and adjust as required.

## **CSF SAMPLE COLLECTION**

### **Equipment**

- Non-sterile gloves
- Chlorhexidine gluconate 2% and Isopropyl alcohol 70% swab
- 10 mL luer lock syringe (a smaller size syringe may create unnecessary vacuum as a result of increased resistance during aspiration of sample) x 2
- 10 mL pre-filled 0.9% NS syringe
- Specimen container(s)

### **Procedure**

- ★ **Note: Double check physician's order to ensure CSF sample is from ordered site (the sample may need to be obtained from the drip chamber or patient's catheter).**

### **From Patient Catheter**

1. Turn stopcock off to external ventricular drainage device.
2. Cleanse sampling port with Chlorhexidine gluconate 2% and Isopropyl alcohol 70% swab for 30 seconds and allow dry time.
3. Attach syringe to sampling port.
  - ★ Notify Neurosurgeon if resistance is felt or if sample cannot be obtained
4. Gently withdraw CSF (minimum 2 mL).
  - Physician may request 1 mL be aspirated and discarded prior to taking a culture and sensitivity specimen (this clears the ventriculostomy catheter and line).
5. Remove the syringe and transfer the sample into the specimen container.
6. Document time, site specimen was taken from, amount, colour, and clarity (presence of blood or sediment in CSF).
7. Ensure appropriate information on laboratory label. Hand deliver samples to laboratory, CSF fluid will not be sent in the pneumatic tube system.



### **From Drip Chamber**

1. Remove cap from side port on “drip chamber stopcock” located at bottom of drip chamber.
2. Cleanse port with Chlorhexidine gluconate 2% and Isopropyl alcohol 70% swab for 30 seconds and allow dry time.
3. Attach syringe to side port and turn stopcock off to the collection bag. Gently withdraw CSF (minimum 2 mL).
4. Remove the syringe and transfer the sample into the specimen container.
5. Open clamps and return stopcock to appropriate position.
6. Document time, site specimen was taken from, amount, colour, and clarity (presence of blood or sediment in CSF).
7. Ensure appropriate information on laboratory label. Deliver samples to laboratory, CSF fluid should not be sent in the pneumatic tube system.

## **4. DOCUMENTATION**

1. At beginning of each shift and as required, assess and document the appearance of the site and dressing, type of monitoring system, alarm settings, transducer zeroed and levelled to the tragus of ear, level of drip chamber on external ventricular drainage system, the degree head of bed is elevated, and record and mount ICP waveform strip on Monitoring Strips (CS-372).
2. Assess and document hourly or more frequently as required, neurological assessment including Glasgow Coma Scale (GCS), vital signs, ICP, CPP, the EDS 3 and transducer is levelled to the tragus of patient’s ear, maintained drip chamber level on external ventricular drainage system, CSF appearance and degree “head of bed” is maintained.
  - CPP normal range 60 –100 mm Hg
  - Normal ICP is 0 – 15 mm Hg
  - CPP calculation
    - Mean arterial blood pressure (MAP) – ICP = CPP
    - When ICP is negative range or MABP = CPP there is no cerebral blood flow.
  - MAP can be taken form automatic BP cuff if no arterial line in place.
3. Observe and document the effects of care on the ICP readings and waveform (i.e., suctioning, turning).
4. Report and document any trends, clinical signs of increasing ICP, dampened waveforms or other concerns to neurosurgeon or intensivist.
5. Document amount, colour and character of drainage every shift or more frequently as required.

## **5. REFERENCES**

- Medtronic. (2014). *Duet external drainage and monitoring system* [Brochure]. Brampton, ON: Author.
- Cox, S. (2017). Intraventricular catheter with external transducer for cerebrospinal fluid drainage and intracranial pressure monitoring. In D. J. Wiegand (Ed.), *AACN procedure manual for critical care* (7th ed., pp. 842-855). St. Louis, MO: Elsevier/Saunders.

Slazinski, T. (2011). Combination intraventricular/fiberoptic catheter insertion (assist), monitoring, nursing care, troubleshooting, and removal. In D. J. Wiegand (Ed.), *AACN procedure manual for critical care* (6th ed., pp. 809-815). St. Louis, MO: Elsevier/Saunders.

Slazinski, T. (2017). Intracranial bolt and fiberoptic catheter insertion (assist), intracranial pressure monitoring, care, troubleshooting, and removal. In D. J. Wiegand (Ed.), *AACN procedure manual for critical care* (7th ed., pp. 829-841). St. Louis, MO: Elsevier/Saunders.

Smith, E. R., Amin-Hanjani, S. (2021). Evaluation and management of elevated intracranial pressure in adults. [www.uptodate.com](http://www.uptodate.com)

**Figure 1.** Levelling the external drainage system. This figure illustrates the leveling of the external drainage system to the Foramen Monro (tragus of ear).

