Management of the Patient with an External Ventricular Drain

Purpose
To appropriately manage the patient with an external ventricular drain (EVD)

1. Set up
2. General care of the patient with an EVD - maintaining security and function
3. Movement of the patient with an EVD safely
4. Emptying the EVD drainage bag cleanly

Definitions

ICP intracranial pressure is the pressure within the skull. Normal ICP is up to 15 mmHg. Values > 20 mmHg may need treatment. Refer to “Guidelines for Management of Severe Head injury”.

CBF cerebral blood flow is the flow of blood through the brain

CPP cerebral perfusion pressure is the effective pressure driving blood through the brain. It is defined as the difference between mean arterial and intracranial pressures: \[ \text{CPP} = \text{MAP} - \text{ICP} \]. Both the arterial and intracranial pressures should have the external auditory meatus as the zero point for CPP. Normal CPP is about 70 mmHg, but when it is less than 50 mmHg there is metabolic evidence of ischaemia and reduced electrical activity. A CPP value of 60mmHg is targeted for traumatic brain injury.

EVD external ventricular drain is a catheter used to measure ICP that also allows external drainage of CSF. The proximal tip of the catheter sits in a lateral ventricle, and the distal end is connected to a drainage system and pressure transducer.

Procedure

Set up of an External Ventricular Drain (EVD)

In patients who have an intraventricular catheter inserted to monitor the ICP and drain CSF, the patient usually returns from theatre with the catheter and drainage system already set up and primed. The equipment below is required to set up the ICP monitoring:

Equipment needed
1 x sterile dressing Pack
Sterile Gloves
Eye protection
Chlorhexidine 0.5% solution in 70% alcohol
1 x ICP Transducer
10ml sterile normal saline (for priming the transducer)
1 x 10ml syringe (only for priming)
1 x ICP holder (with laser spirit level)
Then:

- Wash hands
- Open equipment onto a sterile field
- Perform a three minute-hand-wash. Put on the sterile gloves
- Assemble the ICP transducer system

Note: In patients with only a Codman parenchymal catheter inserted, the catheter is attached directly to the Codman monitor. (See Codman procedure for calibration and set-up)

- Using a sterile technique, flush the transducer set-up with normal saline
- Ensure all air is removed and then put non-venting caps (blue) on the flush port and the un-used port on the side of the transducer
- Encircle ICP monitoring port and the patient’s drainage system port with chlorhexidine soaked gauze for 2 minutes
- Connect the ICP transducer to the patient’s drainage system at the three-way tap closest to the drainage bag, and place onto the ICP holder
- Perform a zero of the catheter prior to commencing monitoring. The zero point is the patient’s external auditory meatus (mid ear)

Note: The ICP is only measured accurately when the drainage system is closed off

- Set alarm parameters for high ICP > 20mmHg and low CPP < 60mmHg
- Ensure the trace is accurate and not dampened
- Record and document the patient ICP and CPP from the Philips monitor. These values should be documented at least hourly (check the desired frequency of observation with medical staff)

General care of the patient with an EVD:

- Always ensure that the dressing to the EVD or lumbar CSF drain is intact, the insertion site should be clean and covered with clear occlusive dressing
- Always level the transducer and drainage chamber at the beginning of each shift and if the patient’s position in the bed alters. There needs to be a prescription stating at what level (in centimetres) the drain is to sit above or below the zero reference point (foramen of Munro), and if the drain is to remain open or closed
- Vital signs and neurological observations including the Glasgow Coma Score must be recorded hourly. ICP and CPP are charted hourly
- Document amount of drainage from EVD or lumbar CSF drain hourly and note the colour
- If there has been no drainage from the drain for one hour when there has previously been drainage or there is an increase in ICP check that there are no clamps on and that the stopcocks are not turned off
- If there is a device error then contact the ICU registrar. The neurosurgical registrar should be contacted if there are any ongoing concerns about patency of the drain
- When the decision to remove the drain has been documented and a medical officer is available to insert a suture, only then can the nurse remove the EVD. The RN can refuse to remove the EVD if a
doctor is not available to insert a suture. A medical officer can remove the drain and insert a suture at the same time. A registered nurse can remove a lumbar CSF drain, as a suture is not usually required.

**Cerebrospinal Fluid (CSF) Sampling:** CSF sampling is to occur every Monday and Thursday at 9am and more frequently if clinically indicated.

- Assemble all equipment required:
  - Dressing pack
  - Sterile gloves
  - PPE
  - Chlorhexidine 0.5% solution in 70% alcohol
  - Sterile yellow top specimen jar
  - 2 ml syringe
  - Interlink access
  - Sterile fenestrated drape

- Explain procedure to patient or family as required

- Measure and record CSF output in the burette for the previous hour

- Don PPE then complete hand wash and put on sterile gloves

- Clean the CSF access port with chlorhexidine and allow to dry

- Attach interlink to syringe and insert into CSF access port

- Aspirate 1ml of CSF for microscopy, cell count, culture and sensitivity. If additional tests are ordered contact pathology for volume required before you take the sample

- Open yellow top container and place specimen into container, being careful not to contaminate specimen

- Document the colour, amount and character of the CSF, the sample port used and the time the sample was taken in Intensys or the Clinical Record if not in ICU

- Ensure that the sample is personally delivered to pathology. Do not use the vacuum tube system

If the sample is taken from the port that is closest to the ventricular catheter insertion site and the patient’s head, tubing distal to the port should be clamped for 5 minutes (no more) to allow the build-up of some CSF in the ventricle. If a three-way tap is present, use that in preference to using a needle, even if it is slightly further away from the patient’s head than the needle-access port. Use a sterile fenestrated drape to cover the line on either side of the access port. Use the steps outlined above, with the exception that 1 ml of CSF is then aspirated slowly over one minute. The tubing must then be unclamped for monitoring ICP or drainage of CSF. Sampling from this port is only done when ordered by the Medical team and not routinely.

**Movement of the patient with an EVD:**

- When transferring patients with EVD or lumbar CSF drain from bed to bed or CT table empty CSF reservoir and **clamp** EVD or lumbar CSF drain immediately prior to transfer and place the drainage system on the patient’s chest. Where ICP monitoring is available – monitor ICP during transport

- As soon as the patient has been transferred and airway secured, re-level the drainage chamber and open the clamp.
Prior to moving the patient from the bed, ensure that the ventricular catheter and drainage device are well secured and free from all cables/lines to prevent inadvertent removal.

**Changing the EVD drainage bag:**

- Ensure stopcock between collection chamber and bag is in the off position
- Don gloves and goggles
- Clean connection area with an alcohol wipe and allow to dry
- Disconnect the old bag and connect the new bag without touching the open connection ends with your hands

**Risk Rating**

Low – For Review 3 years from validation date unless significant and compelling evidence becomes available to indicate a practice change within that time.

**Implementation Plan**

Standard

**Education Notes**

The Monro-Kellie hypothesis states that the skull is a rigid compartment filled to capacity with incompressible substances – 80% brain matter, 10% blood, and 10% CSF. Therefore an increase in one or more of the components results in an increase in the overall pressure within the skull unless another component decreases in volume reciprocally (Hickey, 2009).

If there is an increase in one of the three substances within the skull, there are compensatory mechanisms. These are:

- Displacement of some CSF from the ventricles into the spinal subarachnoid space
- Decreased production of CSF
- Displacement of blood by compression of the low pressure venous system
- Vasoconstriction of the cerebral vasculature, to decrease the intracranial blood volume

Once these compensatory mechanisms have been exhausted, the ICP will rise. If left untreated this will lead to herniation of brain tissue and cerebral hypoxemia due to compression of all blood vessels.

ICP is affected directly by any changes in volume of CSF within the brain. These changes in volume may be the result of:

- Change in the rate of production of CSF
- Obstruction to CSF flow within the ventricular system
- Change in the rate of absorption of CSF

Indications for inserting an ICP monitor are varied and sometimes controversial. The most common indication is closed head injury severe enough to decrease conscious level and require mechanical ventilation. ICP is also monitored in patients with hydrocephalus that require drainage of excess CSF. These patients may not be ventilated but require close monitoring.

There are two main ways of monitoring intracranial pressure:

- Intraventricular catheter (usually called “external ventricular drain” see above. This policy refers to this type of catheter.
- Parenchymal catheter (the catheter tip lies in brain tissue) e.g. Codman catheter. There is a separate Codman policy for set-up and operation.
Placement of an intraventricular catheter

The ICP waveform shouldn’t be dampened. There should be three waves P1, P2 and P3. The top waveform is normal. The bottom waveform shows P2 higher than P1, which indicates raised ICP and reduced brain compliance.

CSF Sampling

Indications
Routine collection of CSF should occur every Monday and Thursday at 9am (more frequently if clinically indicated), taking fresh CSF from the collection port at the bottom of the burette (no more than an hour old). If there is no CSF sitting in the burette, junior staff should contact a senior member of staff for assistance. Under some circumstances, the CSF sample may need to be taken from the port closest to the patient’s head.

Contraindications
- A sample should not be taken within 30 minutes of the administration of intrathecal medications
- Withdrawal of a sample should not be attempted from a drain that is blocked
**Risks and Precautions**

<table>
<thead>
<tr>
<th>Risks</th>
<th>Precautions</th>
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<tbody>
<tr>
<td>Patient at risk of infection</td>
<td>A CSF sample must be taken using the approved sterile technique by, or under direct supervision of, an accredited medical officer or registered nurse</td>
</tr>
<tr>
<td>Disconnection or accidental removal of the EVD or lumbar CSF drain</td>
<td>Ensure that the EVD or lumbar CSF drain is well secured prior to taking the sample. Ensure that the all connections are tight after taking the sample</td>
</tr>
<tr>
<td>Contamination of the specimen during the sampling procedure</td>
<td>Strict attention to sampling procedure as contamination could lead to erroneous diagnosis of infection.</td>
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<tr>
<td>Contamination of the health professional by body fluid contact</td>
<td>Personal protective equipment to be worn as per Area OH&amp;S guidelines</td>
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Normal CSF is essentially a plasma ultrafiltrate and has a very low protein and lipid content. Concentrations of substances should always be compared with those in plasma, because alterations in plasma concentrations are reflected in the CSF even when CNS metabolism is normal. Spontaneous clotting of the specimen occurs when there is excessive fibrinogen in the sample (usually associated with high protein levels).

New fever, leucocytosis, neurological deterioration and change in CSF appearance might indicate nosocomial ventriculitis. Infection rate is high, with reported incidences of 5% up to more than 20%. Risk factors include, non-adherence to strict insertion and maintenance protocols, CSF leakage, and frequency of catheter manipulation (Beer et al).

<table>
<thead>
<tr>
<th>CSF Microbiology &amp; Biochemistry</th>
<th>Normal Values</th>
<th>Significance of abnormal findings</th>
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<tbody>
<tr>
<td>Volume</td>
<td>135-150ml (undrained value!)</td>
<td>Increase with hydrocephalus</td>
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<tr>
<td>Specific gravity</td>
<td>1.007</td>
<td>Increase with contamination by blood or infection</td>
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<tr>
<td>Colour</td>
<td>Clear and colourless</td>
<td>Yellow (= xanthochromia) from red cell breakdown following recent haemorrhage, very high protein levels or systemic jaundice Cloudy from increased white cell count</td>
</tr>
<tr>
<td>Red cell count</td>
<td>Nil</td>
<td>Presence of red cells indicates a traumatic tap (common) or haemorrhage</td>
</tr>
<tr>
<td>White cell count</td>
<td>&lt;5 cells/mm³</td>
<td>&gt;5 cells/mm³ may indicate inflammation or infection</td>
</tr>
<tr>
<td>Protein</td>
<td>15-45mg/100ml (lumbar CSF usually has a higher value than ventricular CSF)</td>
<td>Any condition with excess red or white cells in the CSF will cause raised levels of protein. Mild increase can be seen in viral meningitis, subarachnoid haemorrhage, tumours and multiple sclerosis. Moderate or large increase might be seen in bacterial meningitis, tumours, tuberculous</td>
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Implications of microbiological findings

This policy uses routine collection from a distal site (below the reservoir) to minimize the risk of introducing infection at the time of sampling. If the specimen is normal, there is no infection. If there is a CSF finding that might imply reservoir colonization or ventriculitis, the collection should be repeated from the site closest to the patient to confirm whether ventriculitis is present. Empiric antibiotics may be appropriate while confirmation is awaited.

References and Related Policies

- Bader M, Littlejohns L and Palmer S: Ventriculostomy and intracranial pressure monitoring: In search of a 0% infection rate. Heart and Lung 1995; 24(2): 166-172
- Liverpool Health Service ICU Patient Care Manual, Department of Nursing, 2009
- Codman EDS11 Product information, 2002

Version History

<table>
<thead>
<tr>
<th>Date of Issue</th>
<th>Document Version</th>
<th>Change Details</th>
<th>Author</th>
</tr>
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<tbody>
<tr>
<td>August 2010</td>
<td>2</td>
<td></td>
<td>Amy Thompson CNS</td>
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<tr>
<td>October 2014</td>
<td>3</td>
<td>Updated to NBMLHD</td>
<td>Janet Scott CNC</td>
</tr>
<tr>
<td>December 2014</td>
<td>4</td>
<td>Updated education notes</td>
<td>Danni Phillips CNS</td>
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