External Ventricular Drain

AKA - “EVD”, “ventricular catheter”, “ventriculostomy”

What is it?

An EVD is a device which is inserted into the brain, more specifically into the ventricle(s) of the brain by the neurosurgical team in order to drain CSF. The catheter is tunnelled and brought out through the skin and secured either with sutures or clips to the skin.

Outside the head, this catheter connects to a system consisting of connective tubing including a 3-way tap, a collection chamber, a pressure scale and a drainage bag.

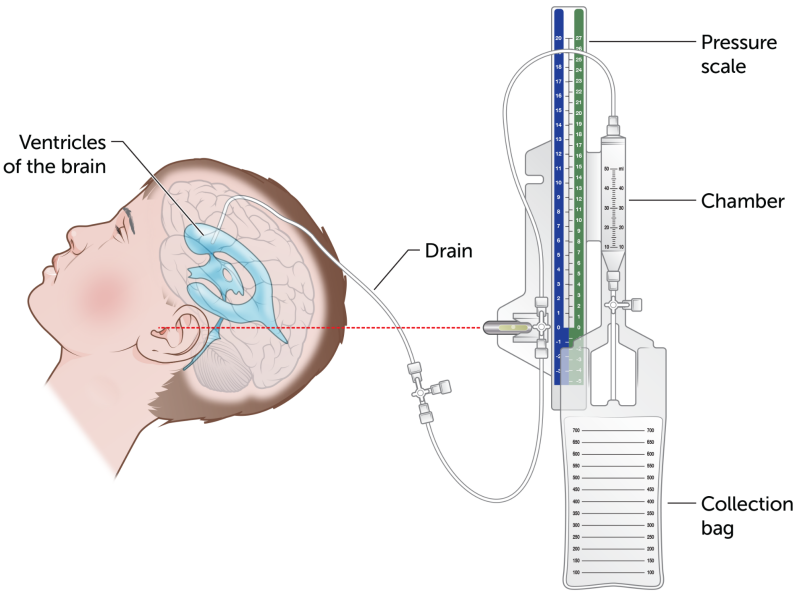
How does it work?

The continuous production of CSF exerts pressure within the ventricles - ‘normal’ intracranial pressure is taken to be between 5 - 15 mmHg (7.5–20 cm H2O).

The EVD can be set to a specific pressure (more on this below) which is the pressure the CSF has to exert inside the head before it drains externally into the EVD. For example, if the pressure valve of the EVD is set to 15cmH_2O, then CSF will only drain out of the head when ICP exceeds 15cmH_2O, thus relieving the pressure. If the pressure inside the head is less than 15cmH_2O then CSF will not drain out.

CSF…

- Drains from the ventricles through a drainage catheter
- Flows through a 3-way tap (samples can be obtained from this using a sterile technique)
- Into a collection chamber
- Is recorded by the nursing/medical team, usually on an hourly basis,
- Then drains into a collection bag.

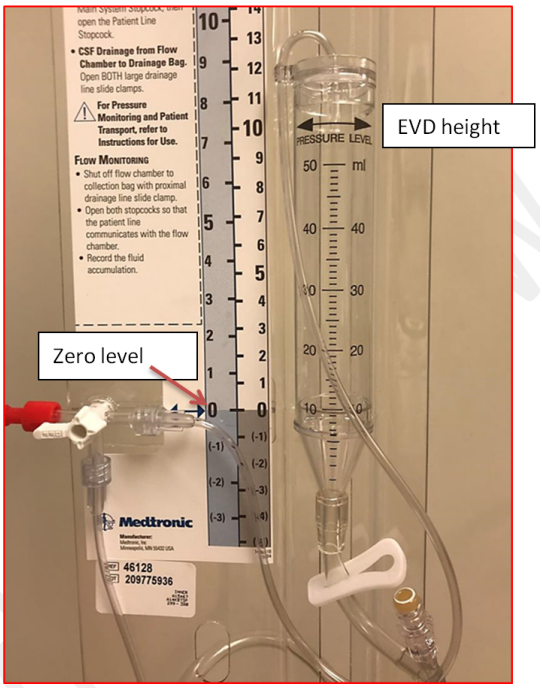


It is important that the scale is correctly calibrated (‘zeroed’) at the level of the patient’s tragus when in the supine position or the bridge of the nose if the patient is lying on their side (as these positions align with the foramen of Monro - the normal anatomical drain of the lateral ventricles). A levelling device, either a spirit level or a handheld laser is used to achieve this.

The pressure within the ventricles is significantly less than the arterial pressure and therefore due to the fixed amount of space within the bony cranial cavity, the flow of CSF from the ventricle through the drainage catheter should be pulsatile as ICP fluctuates with each heartbeat. There is often a very small amount of air in the system and close observation of these bubbles suspended in CSF should show pulsatility, indicating the system is open/ patent

What does it look like?

The image opposite shows the collecting chamber and the pressure scale, also known as the “height” of the EVD. The pressure scale is set by moving the height to the desired number. The desired height will be communicated by the neurosurgeons post-operatively and confirmed daily on ward round.



The zero point on the image should be levelled as above with the patient’s tragus.

The CSF should be a light straw coloured liquid but may be blood stained (this is normal in the hours following EVD insertion or if there is ongoing bleeding into the ventricular system).

What does it do?

An EVD is both a therapeutic device for CSF diversion to relieve raised intracranial pressure ICPas well as a diagnostic device for measuring ICP.

EVDs are considered the ‘gold standard’ method for relieving raised ICP secondary to hydrocephalus. Hydrocephalus can be caused by a variety of pathologies including subarachnoid haemorrhage, intracerebral haemorrhage, bleeding/oedema following traumatic brain injury, obstructive hydrocephalus due to a space occupying lesion, cerebral infection affecting CSF re-absorption and genetic malformations within the brain affecting the normal CSF pathways.
In some cases, medications such as antibiotics can be administered intrathecally via an EVD.

What can go wrong?

The most **common** complications and how to deal with them:

- **No CSF draining**
    - This could be a blockage/ obstruction of the EVD. Troubleshooting steps:
        - → ensure all (3-way or single way) taps are open
        - → assess for pulsatility of the fluid within the catheter,
            - if it is pulsatile, the drain is patent but isn't draining CSF, see *too little CSF draining*.
            - if it is not pulsatile, the drain is potentially blocked, continue to next step.
        - → carefully detach the collecting chamber and lower the entire system to the floor, assessing for CSF drainage for ~30 seconds;
            - if CSF drains after 30 seconds, the system is patent, see *too little CSF*.
            - → if no CSF drains the drain is possibly blocked, contact the neurosurgical team urgently. Assessment of the patency of the drain by a neurosurgeon ± an urgent CT head is needed.
    - Common causes of blockages:
        - Haematoma in the catheter
        - Debris in patients with ventriculitis
        - The ventricular catheter is no longer in the ventricle (a CT head is needed to confirm this)

- **Too much CSF draining**
    - The neurosurgical team will set a parameter for flow rate of the EVD (this may be in the post-op instructions).
    - → If the flow rate is higher than this, contact the neurosurgical team for review.
        - Occasionally, the vertical height (thus pressure) of the EVD system will need adjusting as over-drainage may lead to iatrogenic ventricular collapse, subdural haematoma, aneurysm rupture, headache, and in severe cases, tentorial herniation.
    - If there is a sudden large 'dump' of CSF at once (such as 20-30mL or more) or if the hourly CSF drainage is persistently high (such as 30mL or more hourly) and different to previous hourly drainage, this would warrant a neurosurgical review.

- **Too little CSF draining**
    - If there is little/no CSF draining, ensure the drain is patent by following the troubleshooting steps for *no CSF draining*.
    - The neurosurgical team will set a parameter for flow rate of the EVD. If the flow rate is too low (e.g. 0ml/hr), contact the neurosurgical team for review.
        - Occasionally, the vertical height (thus pressure) of the EVD system will need adjusting as this may lead to iatrogenic hydrocephalus if too little CSF is being drained.

        - In contrast to the above, occasionally the EVD may have drained 25ml/hr for 4 hours and 5ml/hr for 4 hours (an average of 15ml/hr) and this may be acceptable, though should still be discussed with the neurosurgical team.
- **Leaking:**
    - if the wound site is leaking this increases the likelihood of an infection developing.
    - The neurosurgeons should be contacted for review as soon as possible.
    - They are likely to swab it if there is evidence of infection, as well as send a CSF sample. They may also suture the wound if it continues to leak.
    - A leaking EVD site must NOT be ignored

- **Infection**
    - EVDs should be considered as a potential source of infection in any critical care patient with a fever, raised inflammatory markers or new abnormal/ altered neurology.
        - Infection may also be suspected in patients with turbid CSF, see *change in colour of CSF*
    - CSF can be obtained from the three-way tap following consultation with a neurosurgeon.
        - CSF sampling from an EVD MUST be performed in a sterile fashion by an appropriately trained person.
    - → Discuss with the neurosurgical team if infection is suspected as the EVD may need to be replaced.

- **Change in colour of CSF**
    - Normal CSF is usually clear and colourless.
    - CSF from EVDs can be a variety of colours including a light straw colour, pink, slightly bloodstained.
        - Blood (secondary to EVD insertion or ongoing haemorrhage) will lead to blood stained CSF.
            - If the CSF suddenly looks more bloody it could indicate a re-bleed
        - Turbid/ cloudy/ milky CSF usually indicates an inflammatory process, though given one of the indications for EVD insertion is drainage of infected CSF, this may also be the reason for the EVD insertion, but should previously be documented by the neurosurgical team as so.
    - → Consultation with the neurosurgical team should be sought if there is any acute change in CSF colour.

The most **serious** complication

- Blocked EVD, see *no CSF draining*. This may require a return to theatre if an EVD is still indicated but it is blocked.

Key safety point

If in doubt, please contact the neurosurgery team.

Other notes

In addition to the amount the EVD is draining, this should always be correlated with the patient's neurological condition and the drainage should be interpreted as part of a full assessment. If there is a change in neurological condition, the patient must be reviewed and the neurosurgical team informed regardless of the amount the EVD has actually drained.

Patients may have multiple EVDs, as sometimes communication between the lateral ventricles can be obstructed. Each EVD should be assessed/ managed separately as an individual system.

In cases of infection (such as ventriculitis), intrathecal antibiotics may be administered in a sterile fashion through the EVD. If indicated, these are to be administered by a neurosurgeon in a sterile fashion.

Further reading

(Note this is paediatric guidance but the concepts are similar) - https://www.clinicalguidelines.scot.nhs.uk/nhsggc-guidelines/nhsggc-guidelines/intensive-and-critical-care/extra-ventricular-device-guideline-evd/

Image 1 - https://www.rch.org.au/kidsinfo/fact_sheets/External_Ventricular_Drains/, accessed 10/01/22

Image 2 - Donald E. Stout, Michaela X. Cortes, Venkatesh Aiyagari, DaiWai M. Olson, Management of External Ventricular Drains During Intrahospital Transport for Radiographic Imaging, Journal of Radiology Nursing, Volume 38, Issue 2, accessed 10/01/22