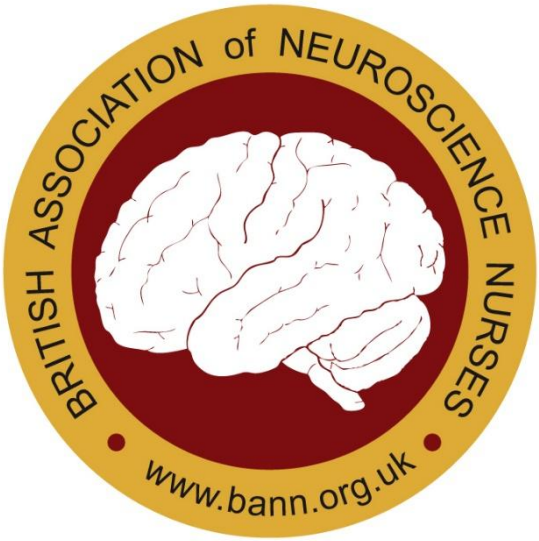
Standard of Practice for the Management of External Ventricular Drains in Adults with Neurological Disorders



The Society of British Neurological Surgeons

British Association of Neuroscience Nurses

Standard of Practice for the Management of External Ventricular Drains in Adults with Neurological Disorders

First Edition

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Authors	Lead author Anne Preece, Head Injury Clinical Nurse Specialist, Lead Neurosurgical Clinical Nurse Specialist, University Hospital Birmingham NHS Foundation Trust Contributing authors This document has been developed and designed in collaboration with BANN Executive Committee members and the Senior Executive Committee Society of British Neurological Surgeons (SBNS) Information in this document has been compiled from professional sources, accurate and expert information and guidance.

Conflict of Interest Statement

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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Rationale:

Several catastrophic incidents have recently occurred involving the management of External Ventricular Drains (EVDs). Subsequent investigations identified that some local Standards of Practice (SOPs) lacked clarity regarding key processes, particularly those relating to the recognition of complications and escalation procedures.

The NHS England National Patient Safety Team undertook a thematic review of patient safety incidents following concerns that risks associated with EVD management could lead to future patient harm unless action was taken. As part of this work, incidents reported to the National Reporting and Learning System (NRLS) and the Learn from Patient Safety Events (LFPSE) service were reviewed to address the patient safety question:

"Is there evidence of patient harm, or risk of harm, arising from mismanagement of external ventricular drains (EVDs) within NRLS/LFPSE reports?"

A total of 1,620 incidents were reviewed, of which approximately 900 were identified as relevant to EVD management and associated patient safety risks.

Although individual Trusts have developed their own policies, these vary considerably, and this lack of consistency may contribute to further incidents and patient safety risks. A key recommendation arising from these findings was the development of a standardised national standard to guide the management of EVDs, addressing an identified gap in practice.

This document provides guidance to support Trusts and healthcare organisations in developing or updating local policies. It is intended for use across the United Kingdom, including Northern Ireland, and Ireland.

All procedures described within this document are intended as guidance only and are neither prescriptive nor exhaustive. They are based on expert consensus, best practice recommendations from the Society of British Neurological Surgeons (SBNS), the British Association of Neuroscience Nurses (BANN), and the available literature.

Foreword:

People who have an External Ventricular Drain (EVD) require to be cared for by professionals with the knowledge and skills to maintain their wellbeing; misuse of an EVD because of a lack of proficiency in their use can lead to serious infections, over drainage, underdrainage and death.

This Standard of Practice (SOP) focuses on management of EVDs to avoid complications, with particular emphasis on reducing the incidence of EVD-associated infections (EVDAI), specifically ventriculitis.

Ventriculitis is common with incidence being reported between 0.8% and 45% (Hoefnagel, 2023; Li, 2023.) UK/Ireland data demonstrates an EVDAI rate of 9.3% (Jamjoom, 2017). The 30-day mortality rates with EVDAI range between 17% - 46% (Walek, 2022).

The presence of EVDAI has been shown to significantly increase duration of EVD placement, rates of Ventriculoperitoneal shunt (VPS) insertion, length of ICU and hospital length of stay (Chadwick, 2023).

Causative organisms include coagulase-negative staphylococci, Staphylococcus aureus and a rising incidence of infection associated with Gram-negative bacteria, particularly in the last decade (De Saram, 2023).

Most antibiotics exhibit a very low permeation rate through the blood/brain barrier, making the treatment of ventriculitis challenging (Li, 2023). Consequently, higher doses of systemic intravenous antibiotics are used, risking organ toxicity and drug interaction. Intrathecal administration of antimicrobials is limited, due to the risk of local neurotoxicity (Tunkel, 2017).

Prevention of infection in the first instance is imperative. The EVD SOP contributes to a ‘culture of safety’, where SOP adherence correlates with clinicians’ confidence in EVD management.

Most significantly, the introduction of an EVD SOP has been shown to reduce infection rates, ranging between 9% to 23% post-SOP (Talibi et al 2020, Walek 2021, Hoefnagel 2023.)

1. Introduction

1.1 Introduction

An external ventricular drain (EVD) is an external cerebrospinal fluid (CSF) drainage system. Other external CSF drainage systems include lumbar drains and externalised CSF shunts. The latter functions effectively as an EVD. An EVD is a closed system that diverts CSF from the ventricles to a collection chamber. They are commonly used in people with neurological conditions to treat disorders of CSF or raised intracranial pressure (ICP). A proportion of these people may require permanent CSF diversion with a shunt.

This document is addressed to all healthcare professionals involved in the management of people with EVDs and externalised shunts.

1.2 Purpose and Scope

The purpose of this document is to provide guidance on best practice and a standard operating procedure (SOP) for doctors, nurses and allied professionals working in the neurosciences department.

People with an EVD will only be cared for in neurosurgical theatres, recovery, neurosurgical ward and the neurosurgical ICU. When transferred between these areas, or when undergoing investigations or procedures in the radiology department, the person must be accompanied by a nurse or doctor who has received appropriate education and is competent in the care of EVD's. It provides recommendations on the insertion technique, management and troubleshooting. The recommendations are based on best practice and were reviewed by all relevant stakeholders.

1.3 Indications and cautions requiring consideration for EVD

1.3.1 Indications:

- Acute hydrocephalus secondary to aneurysmal or traumatic subarachnoid haemorrhage, intracerebral haemorrhage, intraventricular haemorrhage, infection, brain tumour or shunt failure.
- Management of raised intracranial pressure (ICP) following intracranial haemorrhage (e.g. subarachnoid haemorrhage), traumatic brain injury or central nervous system (CNS) infection.
- Temporary CSF diversion for shunt dependent patients (e.g. during antibiotic treatment following removal of an infected shunt).
- After some other cranial procedures/ intraventricular surgery

1.3.2 Cautions requiring consideration:

- Active infection at the insertion site
- Abnormal coagulation

1.4 Education, and Competence

Nursing and medical staff caring for people with EVDs must undertake appropriate education and be assessed as competent prior to using the device. Education and training may consist of an online education package, simulation training and practical tuition.

Competence should be assessed during supervised practice in a clinical area using the appropriate competency assessment tool.

Education and competency records should be maintained by the local education team as per individual Trust protocols.

The EVD competencies required will depend on individual organisation's criteria, governance and staff and should include the following:
For example:

- Core competencies – required by all registered nursing and medical staff involved in the care of EVD's - Knowledge and skills necessary to undertake:
    - General principles of care
    - Monitoring and management of the EVD
    - Positioning the person and the EVD
    - Changing the EVD drainage bag
    - Troubleshooting
- Advanced competencies – required by Neurosurgical medical team, Neurosurgical Clinical Nurse Specialists, Neurosurgical Advanced Clinical Practitioners (ACP). In addition to Core Level EVD knowledge and skills, the advanced practitioner will also be competent in:
    - Transducer set up
    - Sampling CSF from an EVD
    - Flushing and unblocking the EVD
    - Administration of intrathecal antimicrobial therapy
    - Changing the EVD drainage system when the filter is wet, or the system is blocked
    - Removal of the EVD
    - Management of a CSF leak (Neurosurgical medical staff only)

Following initial training and assessment of competence, nursing staff must complete the self-verification of competence statement annually. At annual appraisal, the EVD-related education completed and associated competencies will be reviewed. A formal update is required at least every three years.

All neurosurgical medical staff are to undergo education encompassing the Core and Advanced level EVD competencies. The education will be provided by the nominated EVD clinical competency lead. This will be completed during the induction process and will be documented in the neurosurgical departmental training records.

More frequent updates on EVD-related clinical practice may be required in the following circumstances:

- if the individual has not used the device in the last few months,
- when there are performance issues concerning EVD competency,
- when an individual lacks confidence in caring for a person with an EVD.

1.5 Roles and Responsibilities

Ward Managers/Matrons

- Establish access to appropriate equipment
- Ensure all staff caring for people with EVDs have access to the appropriate education and training.
- Ensure assessment and care of the person is undertaken by appropriately educated and competent staff.
- Ensure any EVD adverse incidents are reported in a timely manner.
- Participate in investigating adverse incidents and implementing actions as required.

ICU and Neurosurgical Ward Education Teams

- Ensure appropriate EVD competencies are completed by all staff caring for people with EVDs.
- Report practice concerns to ward managers.
- Record competency in EVD care as per organisation recording system.
- Maintain accurate education/training records.

Neurosurgical Team

- Ensure that all medical staff involved in the insertion or care of an EVD are aware of local organisation policy and associated SOPs.
- Monitor concordance with local organisations.
- Report and investigate policy non-concordance.
- Report trends regarding policy concordance to neurosurgical governance meetings.

Infection Prevention & Control Team

- Report EVD related infection rates to neurosurgical and ICU governance meetings.
- Monitor concordance with local policy and report concerns to neurosurgical and ICU governance meetings.

1.6 Audit of Clinical Care of EVD's

The EVD bundle of care should be regularly audited by each clinical area monthly. See EVD audit tool document (Appendix 1)

2. Insertion of an External Ventricular Drain

2.1 Insertion

The procedure must be performed by a Consultant Neurosurgeon or neurosurgical trainee in theatre who has been assessed as competent in the procedure or is operating under the immediate supervision of a senior Neurosurgeon. This may also be performed in A&E or ITU in an emergency.

The coagulation profile and antiplatelet/ anticoagulant medication must be evaluated before the insertion and potential contraindications must be excluded.

If the person is on anticoagulation and/if the INR is above normal values, then optimisation should be discussed with the on-call haematologist, given that most EVD insertions are urgent procedures.

In acute life-threatening emergencies, the insertion of the EVD must not be delayed, even if coagulation is not optimised.

In the case of a scheduled procedure then individual organisation policies for anticoagulation must be followed.

2.2 Insertion procedure

- The person's hair and scalp should be visibly clean and clear of debris/dried blood before commencing the procedure.
- Hair around the insertion site should be removed with clippers but this is not essential. However, the skin should be decontaminated with either alcoholic povidone-iodine (betadine) or alcoholic chlorhexidine gluconate (2.0%).
- Standard antibiotic prophylaxis for cranial procedures involving an implant as per organisation microbiology guidelines should be administered prior to skin incision.
- MRSA status may not be known due to the emergency nature of the operation but should not alter the procedure.
- EVD is placed in the standard fashion with all normal surgical aseptic precautions.
- The catheter should be tunnelled at least 10cm away from the skin incision and secured to the skin incorporating a 'pig-tail' strain relief.
- The site of insertion of the EVD catheter should be covered with a semipermeable clear sterile dressing to ensure visibility where possible.
- The catheter should be connected to the external drainage system using standard aseptic non-touch technique (ANTT).

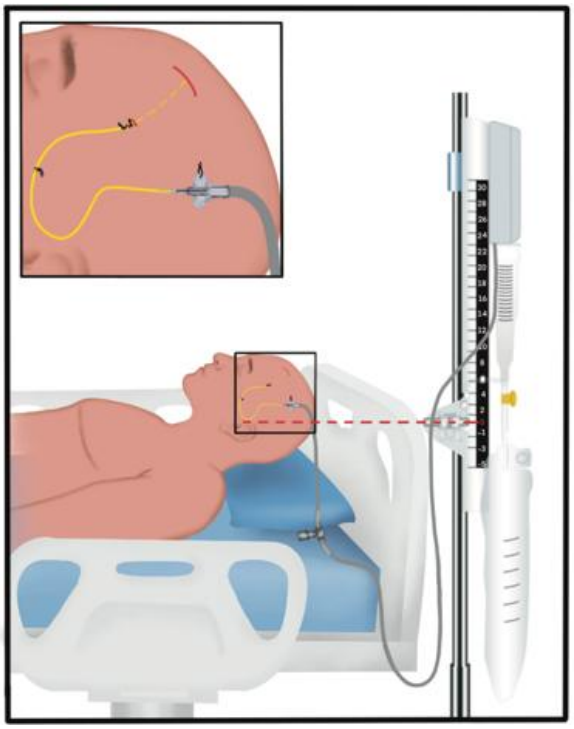

Figure 1. EVD in situ with the zero-point set at the level of the tragus. The inset showed a method of fixing the catheter on the scalp with the use of silk sutures.

2.3 Post Insertion Instructions

It is the responsibility of the surgeon inserting the drain or supervising the insertion to clearly document the prescription for the EVD.

The zero level of the drain should be set at the level of the tragus and the operation note should document the level at which the EVD is to be set. This should also be clearly communicated to the educated and competent registered nurse who is caring for the person post-operatively.

The drainage system will be attached in theatre by the operator while the sterile field remains intact and set at the desired level as determined by the neurosurgeon.

Drainage clamps (3-way taps) are usually opened at the immediate post-operative destination, with clear instructions provided regarding whether drainage is to be:

- **Pressure-led** – where the aim is to drain CSF when intracranial pressure (ICP) exceeds a prescribed threshold; or
- **Volume-led** – where the aim is to drain a prescribed volume of CSF rather than maintain a specific pressure.

If it is not possible to transport the EVD in an upright position, the drip chamber should be emptied and the drain turned off at the patient-line stopcock port to maintain the integrity of the hydrophobic filter.

A LiquoGuard® 7 (digital drainage system) or LimiTorr™ (volume-limiting system) may be used in accordance with local policies and procedures. These systems **must** only be operated by staff who have received specialist training and have been assessed as competent in their use.

3. Nursing Care of the person with an External Ventricular Drain

3.1 Aim

To prevent complications, this guideline provides best-practice recommendations for the nursing care and management of external ventricular drains (EVDs).

The EVD is the responsibility of the registered nurse assigned to the person's care.

3.2 Handover & Prescription

Establish at the start of every shift /on return from theatre the surgeon's prescription/instructions for the EVD.

These instructions should be recorded in the person's Electronic Patient Record (ICU) or clinical notes / Neurosurgical ward EVD care plan, and ideally on the bedside EVD alert poster if available. The EVD prescription should include:

- Whether EVD drainage is pressure-led or volume-led.
- At what height (in cm H_20) above the zero point the EVD is to be set at. (If the patient has an unprotected aneurysm and it is set to less than 15 cm H_20, confirm the EVD prescription with the neurosurgical team.)
- If the EVD is clamped (3-way tap closed) and the ICP is being transduced, clarify the parameters that will guide CSF drainage for example:
    - The ICP threshold at which drainage should occur
    - The volume to be drained
    - The frequency of assessment

These parameters must be prescribed by the neurosurgeon.

3.3 General Principles of Care

Action	Rationale
The gold standard is for EVDs to be connected to CSF-specific tubing and access ports, to prevent confusion with intravenous tubing and inadvertent administration of medications intrathecally. EVD's with integral non-removable NRfit® connectors should be used when available. Specific coloured labels are available in some units.	To prevent confusion with intravenous tubing and inadvertent administration of medications intrathecally.
Minimise EVD manipulation. Any manipulation of the key parts should only be carried out by appropriately educated and competent personnel using sterile gloves and ANTT (Aseptic Non-Touch Technique).	To minimise risk of contamination and infection.

Action	Rationale
Prior to handling the EVD hands must be washed, and appropriate PPE worn (clean gloves and apron).	To minimise risk of contamination and infection.
Fresh, clean pillowcases must always be used on pillows supporting the person's head. Pillowcases that have been used elsewhere for positioning must not be reused for this purpose.	To minimise risk of contamination from the pillow and infection.
Person's hair should NOT be washed while an EVD is in situ	To minimise risk of contamination and infection.
The fluid collection bag should not be changed until more than ¾ full. ANTT should be employed when changing the collection bag. Only those who have been assessed as competent should change the collection bag.	To maintain a closed system and minimise risk of contamination and infection.
The site of insertion of the EVD catheter should be covered with a semipermeable clear sterile dressing where possible. Dressings if used should be changed if no longer adherent, soiled or routinely at 7 days.	Minimise risk of contamination and infection. To minimise direct contact with the EVD insertion site.
During dressing changes, the insertion site should be cleaned with 2% Chlorhexidine gluconate in Isopropyl 70% sterile swabs or 2% chlorhexidine gluconate in 70% alcohol (e.g. ChloraPrep™) or Chlorhexidine Gluconate 0.5% in Isopropyl alcohol 70% (e.g. Hydrex™ Pink)	To decontaminate the insertion site. Not all units use Isopropyl on the wards
ANTT will be used when changing the dressing.	Minimise risk of contamination and infection
ANTT should be used for any manipulation around the insertion site. This includes cleansing of a leak from the insertion site and changing the dressing.	Minimise risk of contamination and infection.
Date of insertion of the EVD and the number of days EVD has been in situ will be recorded in the Electronic Patient Record (EPR) or care plan.	To ensure accurate record keeping.
Atraumatic forceps (blue forceps,) and sterile gauze should always be kept with the person.	To clamp CSF pathway in the event of disconnection or leakage and protect the tubing while waiting for a management decision.

3.4 Hourly EVD Nursing Observations

The observations carried out hourly include the following:

Action	Rationale
Check that the EVD apparatus is positioned correctly as per the surgeon's instructions/prescription i.e. height in cms H_2O	An incorrectly levelled EVD could result in under or over drainage of CSF. Tentorial herniation can occur with over or under drainage.
If the drain is prescribed to be open, ensure that all the taps above the chamber are open. Ensure that the tubing has not been clamped and is not kinked.	To observe for obstruction.
Inspect the vent at the top of chamber to ensure it is dry.	A wet vent compromises the sterility of the drainage system and can impede CSF drainage. The nurse in charge must be informed immediately, and the Neurosurgical Resident on call should be contacted.
Ensure the CSF oscillates with respiration.	If there is no drainage, but the drain is patent, the level of the CSF should be seen to swing because of pulsatile pressure. If the drainage is zero, and the CSF is not seen to swing, this could mean the drain is blocked. See Section 7.
Recording the following: • Colour of the CSF • Opacity Report if cloudy, milky, or turbid, yellow or newly red to the Nurse in Charge (NIC) immediately.	Cloudy, milky or turbid CSF may indicate infection. Yellow/orange CSF (xanthochromic) contains partially broken-down red blood cells from previous haemorrhage. Red –fresh blood, may indicate cerebral haemorrhage or recent surgery.
Measure and record the amount of CSF drained into the chamber at the prescribed time intervals. Turn the 3-way tap off to the person to prevent vacuum formation – open again after emptying. Empty into the collection bag below the drain ensuring the tap is switched off again after emptying.	The amount of CSF drainage is an indication of the ICP. An increase could indicate mounting intracranial pressure. An overfilled chamber will lead to a wet air filter. The EVD collection device will need to be replaced.
Observe the insertion site for an intact dressing, for any signs of CSF leakage and signs of infection. If signs of CSF leakage or infection inform the NIC immediately, (who will inform the neuro surgical team)	As the catheter has direct passage into the brain, there is an increased risk of meningitis/ventriculitis. There is a reported risk of infection of 1-27% with EVD's. If the dressing appears wet at the entry site this could indicate CSF leak.

Action	Rationale
Monitor the person's neurological responses using the GCS and pupillary response at least 4 hourly. Neurological observations (GCS) should be performed more frequently if the drain has been raised or lowered recently or if clamped for transfer or Intrathecal (IT) antibiotics. This is individually dependent.	To detect any deterioration in the person's condition.
Observe the collection chamber frequently between observations and inform the NIC of any changes in volume, colour or consistency of CSF.	To detect any change in the person's condition.

3.5 Positioning

Action	Rationale
The drainage system should be attached in a vertical position to a dedicated drip stand which is not used for any other purpose.	To prevent any confusion and clear identification of the EVD drainage system.
EVD drainage systems measures pressure in centimetres of water (cm H_2O) and/or millimetres of mercury (mmHg). This scale is used to set the hydrostatic pressure level at which cerebrospinal fluid (CSF) will drain from the person's brain. Using the correct scale ensures the correct drainage rate. **Units of Measurement used to for setting the drainage height is cm H_2O (centimetres of water).**	To ensure correct drainage.
People should normally be nursed in a 30° head up position (permitted by their concurrent spine or pelvic trauma); head and neck should be in a neutral, midline position. Endotracheal or tracheostomy ties should not be too tight i.e. two fingers can be inserted between skin and tapes.	30° head up normally decreases the ICP by facilitating cerebral venous drainage.
Zero reference point of the scale on the EVD is set at the tragus of the person's external auditory meatus – see Figure 1.	This corresponds with the Foramen of Monro.
The chamber is set at the height/level prescribed by the neurosurgical team.	This level will determine the amount of CSF drainage.
While many people can tolerate clamping of the drain during the period of mobilisation, it is recommended to keep the drain open and keep the zero level to the prescribed level during mobilisation, adjusting the height as necessary (e.g. level of Tragus). The drain can be clamped for changing positions during mobilisation (e.g. lying to sitting) by switching off the 3-way tap. It is the responsibility of the registered nurse allocated to the person in their care to perform and supervise this process.	To prevent over drainage of CSF or deterioration of the person during repositioning. The presence of a CSF drain should not restrict mobility as early mobilisation improves rehabilitation.

Action	Rationale
When repositioning is finished, confirm that the drain is positioned correctly, with reference to the person, and open the 3-way tap.	To ensure correct drainage of CSF.
Every time the person moves, the EVD must be checked to ensure it is positioned correctly relative to them.	Drainage from the EVD is controlled by the height of the drip chamber relative to the person. It is imperative that neither the drip chamber nor the person be raised or lowered accidentally, as this can causes under or over drainage.
People who are conscious, alert and oriented with an EVD should be instructed to alert their nurse before repositioning themselves in bed. Those who are confused require close supervision and frequent observation to ensure safe EVD management. Both those that are deemed to be alert and oriented and those that are confused require close observations.	To prevent over or under drainage of CSF.
If there is a need to lay the EVD system flat (e.g. when transferring a person) the chamber must be emptied, and the drain closed with the 3-way tap beforehand. The drain will remain closed for the period that the system is not vertical.	If the system is inverted then the filter will become wet, this filter prevents backward flow of CSF and microbes into the system. Drainage may become obstructed and the whole system will need to be replaced.

3.6 Trouble shooting

External ventricular drain malfunction or failure can have serious consequences and can be life threatening so systematic troubleshooting is essential. Troubleshooting aims to minimise the risk of mechanical failure and infection.

3.6.1 Initial assessment

Symptoms suggesting malfunction

- Decreased or no CSF output
- Unexpected increase in ICP readings
- Deterioration of the person (reduced GCS, headache, vomiting, new neurological deficit)
- CSF leakage at insertion site
- Over-drainage (headaches, subdural haematomas on imaging)

3.6.2 Systematic troubleshooting steps

1. Check the basics

- Is the CSF swinging (oscillating) in the tubing?
- Are any of the 3-way taps between the person and drain switched off?
- Is the stopcock correctly positioned to allow drainage?
- Is the zero-point set at the level of the tragus?

- Is the drip chamber at the correct level
- Is the drainage system kinked or disconnected?
- Is the CSF chamber full and needs emptying?

2. Zero the Transducer (if monitoring ICP)

- Ensure the pressure transducer is zeroed at the tragus (external auditory meatus)
- Recalibrate if necessary

3. Inspect the insertion site

- Any CSF leakage?
- Any redness, oedema or signs of infection?
- Is the EVD secured properly

4. Flush the system (if indicated – carried out ONLY by **appropriately trained and competent Neurosurgical medical team or Neurosurgical Clinical Nurse Specialists/ACP's**

- Use ANTT
- Flush towards the drainage chamber. Following a CT a low volume antegrade flush may be used.
- Use preservative–free 0.9% sodium chloride
- Document the flush and CSF clarity
- Check if the malfunction has resolved

3.6.3. Action to take in the event of No drainage

If there has been no drainage from the EVD into the chamber and the drain is unclamped, check that the drain is patent.

Action	Rationale
Observe for signs of the CSF oscillating with respiration.	If there is no drainage, but the drain is patent, the meniscus of the CSF should be seen to swing because of pulsatile pressure. The meniscus should rapidly fall back to the original height when the drain is repositioned.
Unhook the complete drainage system from the drip-stand and whilst holding it, lower and observe for a few drops of CSF dropping into the chamber. **Use with caution as can give false reassurance.**	Drainage from the EVD is controlled by the height of the drip chamber relative to the person.
Do NOT allow more than 3 - 5 drops to drip into chamber when lowering drain to establish patency. Return to original height immediately.	To prevent over drainage.
If the drain is found to be patent, this should be documented.	To ensure accurate record keeping.

Action	Rationale
If this is not observed, return the drainage system to the drip-stand, ensure the drain is not kinked, clamped or leaking and is positioned correctly. Inform the Nurse in charge and the neurosurgical registrar immediately.	A blocked drain may cause a rapid deterioration in the condition of the person. To ensure prompt response to a potentially blocked EVD.

3.6.4 Fresh Blood in the EVD

People with an EVD in situ may bleed and fill the chamber rapidly with fresh blood – **this is a medical emergency**. The drain must be clamped immediately with atraumatic forceps (blue forceps,) and the Neurosurgical registrar contacted urgently.

3.6.5 Accidental Disconnection or Splitting of EVD Tubing

If the drainage system becomes disconnected or shows signs of leaking the ventricular catheter should immediately be clamped with atraumatic forceps (blue forceps). This is to prevent uncontrolled free drainage of CSF. A split or free end should be wrapped in sterile gauze. The neuro surgical team must be contacted urgently and a decision taken to either remove the EVD or to connect to a new drainage system. This will be undertaken by the neurosurgical resident.

3.6.6 Accidental Removal of EVD Catheter

Despite best nursing care, EVD's may on occasion become dislodged or accidentally removed. Cover the exit site with a sterile dressing. The nurse-in-charge should inform the neurosurgical team immediately.

3.6.7 Infection

- Monitor for fever, meningism, purulent CSF or cloudy drainage
- Send CSF for microscopy, culture and cell count if any suspicion
- Start empirical antibiotics if indicated (usually vancomycin + meropenem)

3.7 Audit

Audit should be undertaken monthly to assure concordance with this SOP.

4. Changing the collecting bag of an External Ventricular Drain

This task may only be undertaken by staff deemed competent in Core EVD competencies.
The EVD fluid collection bag should not be changed until it is at least ¾ full.

Action	Rationale
Sterile gloves Dressing pack 2% Chlorhexidine gluconate in Isopropyl 70% sterile swabs or 2% chlorhexidine gluconate in 70% alcohol (e.g. ChloraPrep™) or	Not all units use Hydrex; local antiseptic products and protocols should be followed.

Action	Rationale
Chlorhexidine Gluconate 0.5% in Isopropyl alcohol 70% (e.g. Hydrex™ Pink) New collection bag Trolley Sterile bung	
ANTT must be used throughout the procedure.	To prevent contamination of the EVD system.
Put on appropriate PPE i.e. apron and goggles.	Correct preparation for aseptic procedure. Protection of the eyes from body fluids.
Wash hands and clean trolley.	Correct preparation for aseptic procedure.
Prepare equipment onto trolley top.	
Check tap on the collection chamber is closed.	
Wash hands, sterile towel to dry hands. Don sterile gloves.	Correct preparation for aseptic procedure.
Using ANTT, clean the bag connector/tubing with 2% Chlorhexidine gluconate in Isopropyl 70% sterile swabs or 2% chlorhexidine gluconate in 70% alcohol (e.g. ChloraPrep™) or Chlorhexidine Gluconate 0.5% in Isopropyl alcohol 70% (e.g. Hydrex™ Pink) and allow to dry for at least 30 seconds.	Safe sterile preparation of equipment.
Remove bag and attach bung to seal contents.	
Attach new bag.	
Re-open 3-way tap.	To allow CSF to continue to drain.
Check that fluid is pulsating within tubing.	
Clear away into clinical waste and wash hands.	Safe disposal of waste.

5. Accessing an External Ventricular Drain

5.1 The method described below details the initial actions to be performed prior to undertaking one of the following procedures:

Section 6 - Connection of a transducer to an EVD

Section 7 - Flushing a blocked EVD

Section 8 - Instilling intrathecal antibiotics

Accessing an EVD	Rationale
Sterile dressing pack 2% Chlorhexidine gluconate in Isopropyl 70% clinell sterile swabs or 2% chlorhexidine gluconate in 70% alcohol (e.g. ChloraPrep™) or Chlorhexidine Gluconate 0.5% in Isopropyl alcohol 70% (e.g. Hydrex™ Pink) Second pair of sterile gloves Gauze swabs (2 packs of 5 swabs) 2 x 5ml syringe 1 universal sterile (male / female) bung	Not all units use Hydrex; local antiseptic products and protocols should be followed.
Prepare a dressing trolley for aseptic procedure, cleaning with detergent wipes using a single use detergent wipe for each surface.	Correct preparation for aseptic procedure.
Explain procedure to the person and gain verbal consent for procedure (if able to give consent).	Well informed and prepared person will help to promote a smooth procedure.
Prepare the person; ensure they are lying comfortably on the bed with their head supported.	A comfortable person will promote a smooth procedure.
When measuring ICP, the person should normally be positioned in a 30° head-up position. The person's head and neck should be in a neutral, midline position.	Optimum position for measuring ICP.
Clamp the EVD distally to the 3-way tap closest to the person's head	To prevent accidental sampling from distal tubing.
Wash your hands, put on appropriate PPE i.e. apron and goggles. Prepare your trolley, opening your equipment in a sterile manner.	To minimise risk of contamination and infection.
Put on sterile gloves.	Necessary to undertake the procedure as a fully aseptic technique.
Organise your aseptic field and prepare equipment, soaking gauze in cleaning solution and separating individual swabs to ensure ease of use.	Safe sterile preparation of equipment. Ease of use.
Locate EVD 3-way tap closest to person's head, using one of the gauze swabs soaked in cleaning solution, ensure the tap is "off" to the port and place the 3-way tap onto the sterile towel from dressing pack.	To ensure no air enters the system when the bung is removed.

Accessing an EVD	Rationale
Holding the identified tap in the 2% Chlorhexidine gluconate in Isopropyl 70% sterile swabs or 2% chlorhexidine gluconate in 70% alcohol (e.g. ChloraPrep™) or Chlorhexidine Gluconate 0.5% in Isopropyl alcohol 70% (e.g. Hydrex™ Pink) clean the EVD tubing, using a separate swab for each direction: • 1st: proximally towards the head • 2nd: distally towards the collection chamber • 3rd: around the 3-way tap • 4th: remove the bung and discard • 5th: clean around where the bung was located. Place the 3-way tap back onto the sterile field and allow the chlorhexidine to dry naturally.	To ensure the area to be accessed is as clean as possible
Discard gloves and apply second pair of sterile gloves.	To enable the procedure to be carried out under asepsis.
Access the EVD 3-way tap with a 5ml syringe.	5ml syringes cause the least amount of pressure / suction within the system, causing the least potential damage.
You are now ready to undertake one or more of the following procedures: a. Connection of a transducer to an EVD b. Instilling intrathecal antibiotics c. Flushing a blocked EVD	

6. Connection of a transducer to an External Ventricular Drain

6.1 Introduction

The EVD can at the request of the neurosurgical team be used to transduce the ICP. When this occurs, the transducer should ideally be set up in theatre under sterile conditions, at the time of EVD insertion.

If setting up of transducing equipment is required in the 'ward' environment, it should only be undertaken by staff deemed competent in Advanced EVD competencies.

Action	Rationale
A transducer set (as for transducing a central line) X 2 10ml syringes pre-filled with 0.9% Sodium Chloride Sterile dressing pack 2% Chlorhexidine gluconate in Isopropyl 70% sterile swabs or 2% chlorhexidine gluconate in 70% alcohol (e.g. ChloraPrep™) or Chlorhexidine Gluconate 0.5% in Isopropyl alcohol 70% (e.g. Hydrex™ Pink) Transducer cable	

Action	Rationale
Firstly, proceed as for **Section 5 Accessing the EVD**	
ANTT (Aseptic Non-Touch Technique) must be used throughout the procedure.	To minimise risk of contamination and infection.
Open the equipment. The transducer is the only part required – discard the giving set and tubing.	Timely gathering of all equipment allows for safe and smooth procedure.
Prime the transducer with 0.9% Sodium Chloride using a pre-filled syringe where possible and then put a bung on the end which would normally be attached to the pressure bag.	A fluid filled pathway ensures accurate measurements.
Clean the 3-way tap as previously described and allow to dry.	To maintain asepsis.
Attach the transducer.	To enable pressure monitoring.
Attach the pressure cable from the monitor to the transducer and label the parameter as “ICP”.	To enable pressure monitoring.
Zero the transducer (off to person/open to air). This should be performed at the start of each shift.	The accuracy of ICP readings depends on positioning of the person in relation to the transducer.
Observe screen for ICP waveform – this should look similar to a damped arterial trace.	To confirm the patency of the EVD.
Turn stopcock so it is “**off”** to the collection chamber and “**on”** to the person and transducer.	CSF drainage and accurate ICP measurements cannot be done simultaneously.
Check for a waveform - If no waveform is visible: - Check scale on monitor - Check patency of EVD - Inform NIC who will confirm that the above actions have been taken and then inform the Neurosurgical team.	Lack of waveform may be indicative of a blocked EVD.
When a waveform is visible allow it to stabilise for approx. 1 minute before documenting ICP.	An immediate measurement may be inaccurate.
Turn stopcock so it is **off** to transducer and **on** to person and collection chamber.	To allow CSF to continue to drain.

In certain circumstances, you may be instructed as per surgeon instructions/prescription to leave the EVD transducing and, if the ICP rises above a specified threshold for a defined period, to drain a prescribed volume of CSF before returning the system to transducing.

Ensure that the volume of CSF drained is clearly documented each time the EVD is opened.

7. Flushing a blocked External Ventricular Drain

7.1 Introduction

When an EVD stops draining CSF, this may be due to:

- Occlusion by kinked/clamped tubing or 3-way tap turned to off
- Damage/leak in tubing
- Air filter malfunction
- Debris/blood in the tubing distal to the 1st 3-way tap
- Debris/blood in the tubing or ventricular catheter proximal to the 1st 3-way tap
- Empty/decompressed ventricles or very low CSF pressure
- Migration of ventricular catheter

7.2 Flushing a malfunctioning EVD system

Following assessment, the neurosurgical registrar or consultant may decide to flush a blocked EVD. Flushing the tubing distal to the 1st 3-way tap can be carried out safely by following the protocol below.

Flushing the tubing proximal to the 1st 3-way tap (i.e. into the ventricle) is a potentially harmful procedure and must only be undertaken by Neurosurgical medical staff who have completed Advanced level EVD competencies.
The position of the ventricular catheter **must be** confirmed with a CT scan before attempting to flush proximally.

Flushing a malfunctioning EVD system	Neurosurgical team only
• 2 x 10ml pre-filled 0.9% sodium chloride syringes • 1 x 10ml syringe • 1x 2ml syringe	
Firstly, proceed as per **Section 5 - Accessing the EVD**	Safe accessing of EVD.
Do the following: • Attach the 10ml pre-filled syringe to the access port • Turn the 3-way tap to “off” to the patient and gently flush the distal tubing with 10ml 0.9% n • Turn the 3-way tap to “off” to the port access and observe the flow of CSF • If there is still no flow despite flushing distally then turn the 3-way tap “off” to the distal tubing and attach the 2ml syringe. Gently aspirate – if not able to aspirate then consider flushing proximally with up to 3mls from a 10ml pre-filled 0.9% sodium chloride syringe	Equipment used for flushing system. To clear the distal tubing of any debris or blood clots. If you have cleared the blockage, drops of CSF into the collection will be noted. To flush the proximal catheter to re-establish patency.

Flushing a malfunctioning EVD system	Neurosurgical team only
Flushing of the proximal catheter should only be undertaken by Neurosurgical medical staff who have completed Advanced level EVD competencies, who have confirmed that the proximal catheter is within the ventricle.	Flushing a catheter that is not in the ventricle will result in a saline bolus to the parenchyma, potentially causing harm to the patient.
Turn the 3-way tap to “off” to the port access and observe for flow of CSF.	You should see drops of CSF drip into the collection chamber if patency has been re-established.
Once patency is re-established place universal bung on 3-way tap access port, leaving the drain on open drainage to collection chamber and ensuring chamber is at correct level as per neurosurgeon’s instructions.	For on-going safe drainage of CSF.
Discard sharps safely according to trust policy.	Safe disposal of sharps.
Discard used dressing bag according to trust policy.	Safe disposal of used dressing packs.
Record procedure in medical notes. Ensure the prescription chart has been signed.	Contemporaneous recording is best practice NMC/GMC.

8. Intrathecal administration of medicines via an EVD

8.1 Personnel

The administration of antimicrobial drugs via the EVD may only be undertaken by healthcare professionals and Neurosurgical medical staff who have completed Advanced level EVD competencies.

Administration of intrathecal (IT) medications	Neurosurgical medical staff only
Dressing trolley and sterile dressing pack • IT medication prescription form • IT medications to be administered • x 5ml syringe for flushing • 2 x blunt needle for drawing up • 10mls pre-filled 0.9% sodium chloride for flushing • 1 x 2ml syringe if giving gentamicin • 2% Chlorhexidine gluconate in Isopropyl 70% sterile swabs or 2% chlorhexidine gluconate in 70% alcohol (e.g. ChloraPrep™) or Chlorhexidine Gluconate 0.5% in Isopropyl alcohol 70% (e.g. Hydrex™ Pink) • 2 pairs of sterile gloves • Gauze swabs • 1 universal sterile (male/female) bung • Sharps container	
When organising trolley (as per accessing EVD above) prepare the antibiotics and the flush. Draw up antibiotics and ensuring no air is present in the syringes. Set out on sterile field within easy reach.	Safe preparation of medications. Ensure ease of use when undertaking procedure.
Proceed as per **Section 5 – Accessing EVD**	Safe access.
Insert one of the syringes containing IT antibiotics into the port of the 3-way tap.	To allow the antibiotic to be instilled.
Turn the 3-way tap to “off” to distal tubing.	To allow the antibiotic to be instilled.
Gently aspirate to ensure no air is in the system, knocking any air bubbles to the top of the syringe.	To prevent pneumocephalus.
Administer the antibiotic.	As per prescriber’s instructions.
Turn the 3-way tap to “off” to the port access.	To prevent air entering the system when the syringe is removed.

Administration of intrathecal (IT) medications	Neurosurgical medical staff only
Repeat previous 5 steps as necessary to administer all medications prescribed.	To give all medications prescribed. There is no correct order the medications need to be given in.
When all medications have been administered, flush the EVD tubing with up to 3ml of 0.9% sodium chloride from a 10ml pre-filled syringe using a push pause technique.	To ensure the medications reach the ventricles.
Once the flush had been administered the 3-way tap should be turned to “off” to the port access and the syringe should be removed.	The procedure has ended, and access is no longer required.
Place the universal bung in situ to close the system.	Ensure system is closed to maintain asepsis
The 3-way tap should be left “off” to the distal tubing for 1 hour.	To prevent the antibiotics draining out of the ventricular system – this should be occluded for 1 hour.
Report the occlusion of the drain to the nurse looking after the person.	To ensure the nurse “unclamps” the EVD after 1 hour.
Discard sharps safely according to trust policy.	Safe disposal of sharps.
Discard used dressing bag according to trust policy.	Safe disposal of used dressing packs.
Record procedure in medical notes. Ensure the prescription chart has been signed.	Contemporaneous recording is best practice NMC/GMC.

9. Sampling CSF from an External Ventricular Drain

9.1 Risk factors for EVD-related infection

a. Prolonged duration of EVD placement (particularly over 10 days)
b. Leakage from the EVD insertion site
c. Increased frequency of manipulation or sampling of the EVD.

9.2 Clinical signs of EVD associated infection

a. Headache
b. Nausea
c. focal neurological deficit
d. reduced conscious level
e. new hydrocephalus
f. Pyrexia
g. Neutrophilia and raised inflammatory markers
h. Change in the appearance of the CSF e.g., cloudier or with visible debris.

9.3. Imaging

CT with contrast or MRI scanning may aid detection of EVD-associated ventriculitis and abscesses.

9.4 Assessing the risk of CSF sampling via the EVD

Increased frequency of sampling of CSF via the EVD is one of the main risk factors for introducing infection into the EVD. Any decision to sample the CSF should be carefully considered. Many people with an EVD in situ are critically unwell in ICU. The aetiology of fever in the critically ill person is broad and may be related to other localising infections, e.g., pneumonia or to the presence of other in-dwelling medical devices. Furthermore, people with neurological disorders may experience a persistent fever mediated by hypothalamic dysregulation as a complication of their brain injury.

Repeat sampling of CSF within 72 hours of a previous negative sample should be performed only with the approval of a consultant in either Neurosurgery or Intensive Care Medicine.

The clinical tool (below) is an example for assessing the risk of EVD associated infections for guidance.

At least 3 of the following parameters should be present prior to initiating CSF sampling from an EVD	**Tick**
1. Temp 38.5C or persistent pyrexia	
2. Rising CRP or neutrophilia	
3. Clinical signs of altered or deteriorating neurological function	
4. Change in the appearance of the CSF	
5. Absence of an alternative source of new infection, e.g. Pneumonia	
Note: A consultant (ICU or Neurosurgery) should be aware of all suspected EVD-associated infections.	

9.5 Sampling

Sampling of CSF via the EVD is a procedure only undertaken by healthcare professionals and Neurosurgical medical staff who have completed Advanced level EVD competencies.

People with an EVD will require CSF sampling before conversion of EVD to ventriculo-peritoneal shunt.

A dedicated CSF sampling port or burette should be used in preference to a 3-way tap for sampling depending on which EVD systems are used (see Figure 2 and Figure 3.)

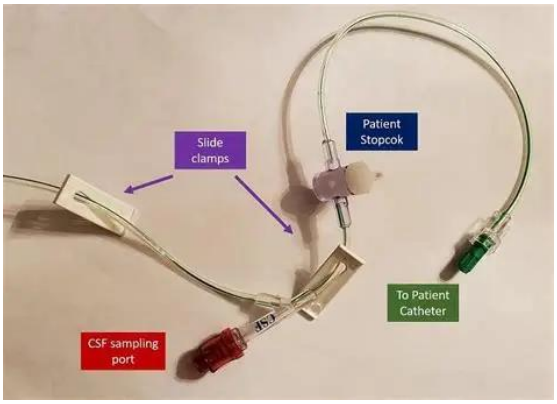

Figure 2. CSF Sampling port

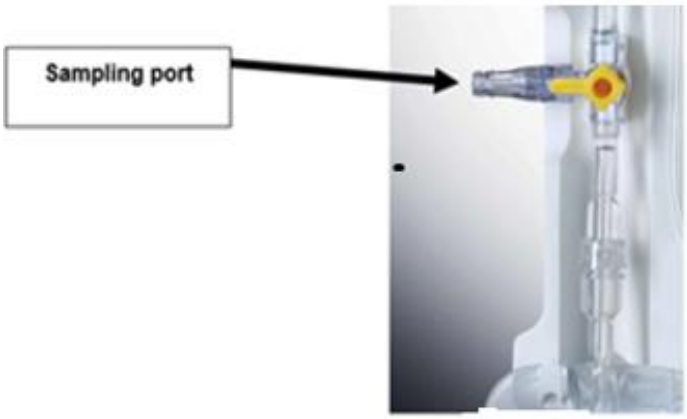

Figure 3. CSF Sampling port

Action	Rationale
Sterile dressing pack • 2% Chlorhexidine gluconate in Isopropyl 70% sterile swabs or 2% chlorhexidine gluconate in 70% alcohol (e.g. ChloraPrep™) or Chlorhexidine Gluconate 0.5% in Isopropyl alcohol 70% (e.g. Hydrex™ Pink) 2 pairs of sterile gloves Sterile container	
Surgical aseptic no touch technique must be used throughout the procedure.	
Prepare a dressing trolley for aseptic procedure, cleaning with detergent wipes using a single use detergent wipe for each surface.	Correct preparation for aseptic procedure.
Gather all the equipment.	Timely gathering of all equipment allows for safe and smooth procedure.
Explain procedure to the person to gain verbal consent for procedure if able.	Well informed and prepared people will help to promote a smooth procedure.
Support the person into a comfortable position on the bed with their head supported.	A comfortable person will promote a smooth procedure and be more likely to be co-operative.
Clamp the EVD distally to the sample port (Figure 2) or open the yellow tap to the burette (Figure 3)	To prevent accidental sampling from distal tubing.
Wash your hands, put on your apron, and prepare your trolley, opening your equipment in a sterile manner.	To minimise risk of contamination and infection.
Put on your sterile gloves.	Necessary to undertake the procedure as a fully aseptic technique.
Organise your aseptic field and prepare equipment, soaking gauze in cleaning solution and separating individual swabs to ensure ease of use.	Safe sterile preparation of equipment. Ease of use.

Action	Rationale
Locate the dedicated CSF sampling port. Using a sterile gauze swab place the sampling port onto the sterile towel from dressing pack.	To ensure no air enters the system when the bung is removed.
Holding the CSF port in the chlorhexidine swab clean the CSF sampling port thoroughly, cleaning on or around the site of attachment for the syringe, using antiseptic solution such as ChloraPrep™	To ensure the area to be accessed is as clean as possible.
Place the CSF sampling port back onto the sterile field and allow the chlorhexidine to dry naturally.	Chlorhexidine must be allowed to completely dry to achieve asepsis.
Discard first pair of gloves and apply the second pair of sterile gloves	To enable the procedure to be carried out under asepsis.
Access the sampling port with a 5ml syringe. Gently aspirate 3-5 mls and discard. Apply second 5ml syringe, aspirate 2mls, remove syringe	Taking a discard ensures you are sampling ventricular CSF and not fluid within the reservoir. 1–2ml is sufficient for submission to laboratory for microbiology and biochemistry.
Transfer the aspirated fluid to the sterile container without touching the sides of the container. Secure lid of specimen container Label correctly at the bedside. Hand-deliver to the laboratory having pre-warned the microbiology biomedical scientist by telephone.	Ensures there is no contamination of the sample. Correct labelling ensures correct result for correct patient as per trust policy. Timely submission to laboratory will ensure timely results.
Discard used dressing bag into the clinical waste bin according to trust policy and clean trolley using detergent wipe and return to storage place.	Safe disposal of waste
Record procedure in medical notes.	Contemporaneous recording is best practice. NMC/GMC

10. Managing the leaking External-Ventricular Drain

Observation of a leak of CSF must prompt urgent assessment and intervention by the neurosurgical medical team.

10.1 Assessment

a. Ensure person's GCS and neurological status is unchanged
b. Inspect the length of the EVD system to identify the site of the leak.
c. If the leak is coming from the tubing or connections, clamp the tubing with atraumatic forceps proximal to this and cover with chlorhexidine-soaked sterile gauze. Inform the neurosurgical team immediately. Replacement of the EVD drainage system may be

necessary which should be carried out by a member of the neurosurgical team using full ANTT precautions.

d. If the leak is from the tunnelled EVD exit site or surgical incision, ensure that the EVD is patent as bypassing can indicate blockage. Check if the drain is set too high or blocked **before** suturing the exit site. If not patent, attend to this as described in section 8.

10.2 Method

a. If satisfactory functioning of EVD then proceed as below
b. Using aseptic technique and chlorhexidine skin preparation, place a deep 2-0 silk suture to underrun the EVD at the exit site to prevent leak.
c. Glue or other methods such as compressive dressings/ Steri-Strips™ should not be used.
d. If continual leak, despite the suture, the nursing staff should inform the neurosurgical medical team.

11. Removal of an External Ventricular Drain

11.1 Personnel

Removal of the EVD should be done by healthcare professionals and Neurosurgical medical staff who have completed Advanced level EVD competencies.

11.2 Method

a. The EVD is usually removed after a stable period of observation over 24 hours whilst the EVD is clamped. Typically, the GCS will be recorded 2-4hrly during this time.

b. Ideally, where circumstances permit, the EVD should be removed at least 12 hours after any previous dose of Enoxaparin. Enoxaparin should not be given for a minimum of 6 hours post removal of the EVD. The treating surgeon may on occasion give a more tailored recommendation.

c. Prior to removal, the exit site and surrounding skin should be cleaned with 2% Chlorhexidine gluconate in Isopropyl 70% sterile swabs or 2% chlorhexidine gluconate in 70% alcohol (e.g. ChloraPrep™) or Chlorhexidine Gluconate 0.5% in Isopropyl alcohol 70% (e.g. Hydrex™ Pink)

d. All securing stitches/staples should be removed and the drain carefully retracted.

e. The drain should be inspected to ensure there is no retained material.

f. A deep suture should be placed to encircle the tract and prevent CSF leak.

g. The procedure should be documented in the medical notes with instructions to remove stitches at an appropriate time (approximately 5 days).

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13. Authors and Acknowledgments

British Association of Neuroscience Nurses

Anne Preece, Committee member, Lead Neurosurgical CNS, University Hospital Birmingham NHS Trust
Dr Mary E. Braine, BANN President
Professor Neal Cook, Committee member, Head of School, School of Nursing and Paramedic Science Nursing, Ulster University

Beaumont Hospital Dublin Ireland
Ms Deirde Nolan, Clinical Nurse Manager Research & Audit
Ms. Annamma Mathew, Clinical Practice Support Nurse

Cambridge University Hospitals NHS Foundation Trust
Mr Prabhjot Singh Malhotra, Specialist Registrar- Neurosurgery
Mr Conor Gillespie, Specialist Registrar- Neurosurgery)
Mr Matthew Garnett, Consultant Neurosurgeon (Project Lead)
Rebecca Legge, Clinical Nurse Specialist-Neurosurgery Lead
Elenita Robinson, Practice Development Nurse Lead-Neuro

Institute of Neurological Sciences Queen Elizabeth University Hospital Greater Glasgow & Clyde

University Hospital Birmingham NHS Trust
Mr Georgios Tsermoulas
Mr Athanasios Zisakis
Anne Preece Lead Neurosurgical CNS
Ms Marian Byrne, CSF Clinical Nurse Specialist

University Hospital Plymouth NHS Trust
Surg Cdr S Dickson
CN P Branfield
Mr Owen Davies

University Hospital of Wales
Ms Kat Whitehouse

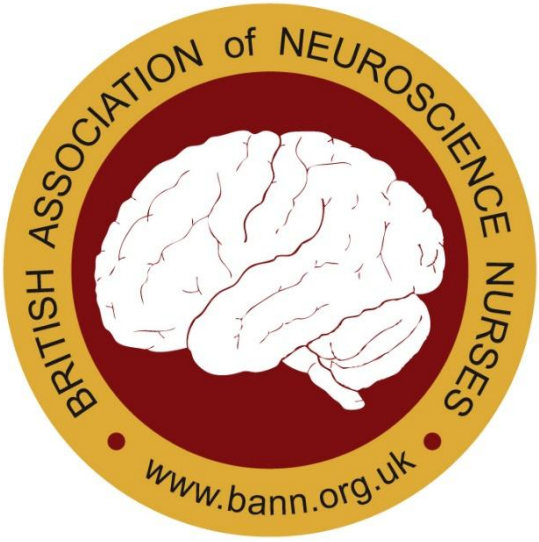
NHS National Hospital for Neurology and Neurosurgery
Mr Lewis Thorne

Appendix 1 - EVD Clinical Practice Audit Tool

Audit to be undertaken once per month.
All patients with EVDs to be audited on that date. Narrative to explain variation from standard.

Standard	Yes	No
1. Drainage system attached in vertical position to the bed?	☐	☐
2. Correct scale in use?	☐	☐
3. Patient nursed Head up 30^0?	☐	☐
4. Zero reference point level with tragus of the ear (supine) or mid sagittal line if patient on their side?	☐	☐
5. Prescription for height of the drain documented?	☐	☐
6. Height of drain corresponds with the prescription?	☐	☐
7. EVD tubing is labelled as such?	☐	☐
8. Pillow case appears fresh and clean?	☐	☐
9. Sterile dressing in place?	☐	☐
10. Nurse knows to wash hands and don appropriate PPE (clean gloves and apron) before handling the EVD?	☐	☐
11. Evidence that the fluid collection bag has not been changed unless more than ¾ full?	☐	☐
12. Nurse knows to change the dressing every seven days or if no longer adherent?	☐	☐
13. Nurse knows to use Surgical ANTT for any manipulation around the insertion site. This includes mopping of a leak from the insertion site and changing the dressing?	☐	☐
14. Nurse knows to clean the insertion site with 0.5% chlorhexidine gluconate in 70% alcohol (pink prep) and allowed to dry when changing the dressing?	☐	☐
15. Atraumatic forceps (blue forceps) are available at the bedside?	☐	☐
16. Nurse caring for the patient can describe when to use the atraumatic clamps?	☐	☐
17. Vent on the collection chamber is dry?	☐	☐

Standard	Yes	No
18. Nurse caring for the patient has undertaken their core level competencies?	☐	☐
19. Nurse caring for the patient can explain who can set up a transducer on the EVD, change the drainage system and sample from the EVD?	☐	☐
20. Nursing caring for the patient can describe what action to take if there is a need to place the EVD system flat?	☐	☐
21. Date of insertion of the EVD and the number of days EVD has been in situ is recorded in the Electronic Patient Record (EPR) or care plan.	☐	☐
22. Nurse caring for the patient knows not to wash the patient's hair while an EVD is in situ?	☐	☐
Total / 22		
Percentage "Yes"		



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