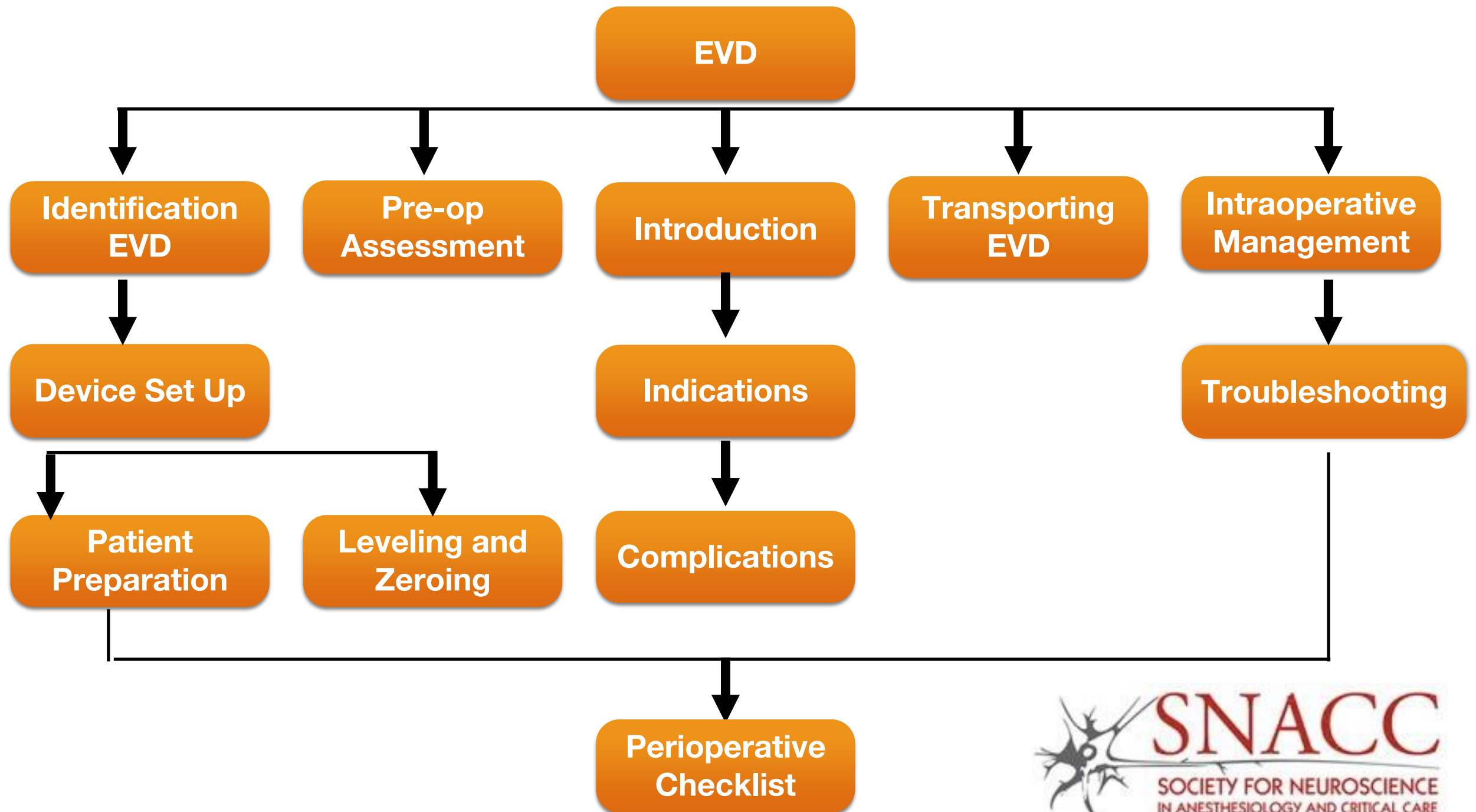


Perioperative Management of External Ventricular Drain (EVD)

Educational Document from the Society of Neuroscience in Anesthesiology & Critical Care (SNACC)

SNACC Task Force for Perioperative Management of EVD & LD



**This Presentation is Free of
Commercial Bias**

**SNACC does not endorse any
particular EVD system
manufacturer**

Acute symptomatic hydrocephalus

Aneurysmal Subarachnoid Hemorrhage (SAH)

Intracerebral and Intraventricular Hemorrhage with decreased level of consciousness

Acute ischemic cerebellar stroke in concurrence with decompressive craniectomy

ICP monitoring in Traumatic Brain Injury (TBI)

TBI with post resuscitation GCS of 3-8, and abnormal computed tomography (CT) scan defined as one with hematomas, contusions, swelling, herniation or compressed basal cisterns

Severe TBI with a normal CT scan if two or more of the following features are noted on admission (age over 40 yrs., unilateral or bilateral motor posturing, or SBP < 90 mmHg)

Management of patients with intracranial hypertension after TBI

Malfunctioning or infected ventriculo-peritoneal shunts, and other neurological emergencies occurring due to infective, and neoplastic diseases

Facilitation of intraoperative brain relaxation

Targeted therapeutic interventions

Recombinant tissue Plasminogen Activator in patients with IVH (efficacy and safety uncertain) and in patients with SAH

Treatment of vasospasm after aneurysmal SAH

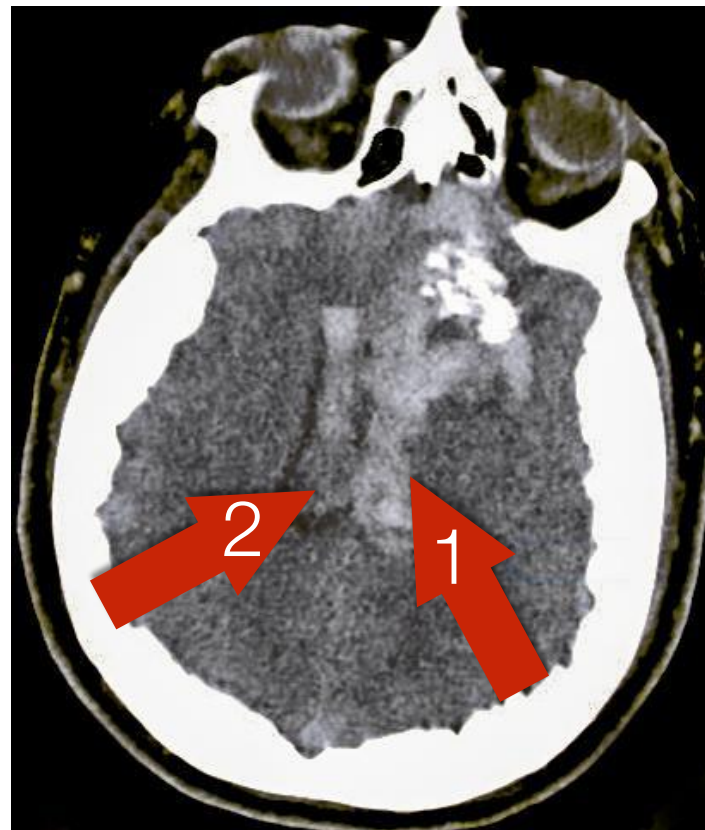
Antibiotics in management of central nervous system infections

Introduction to EVD

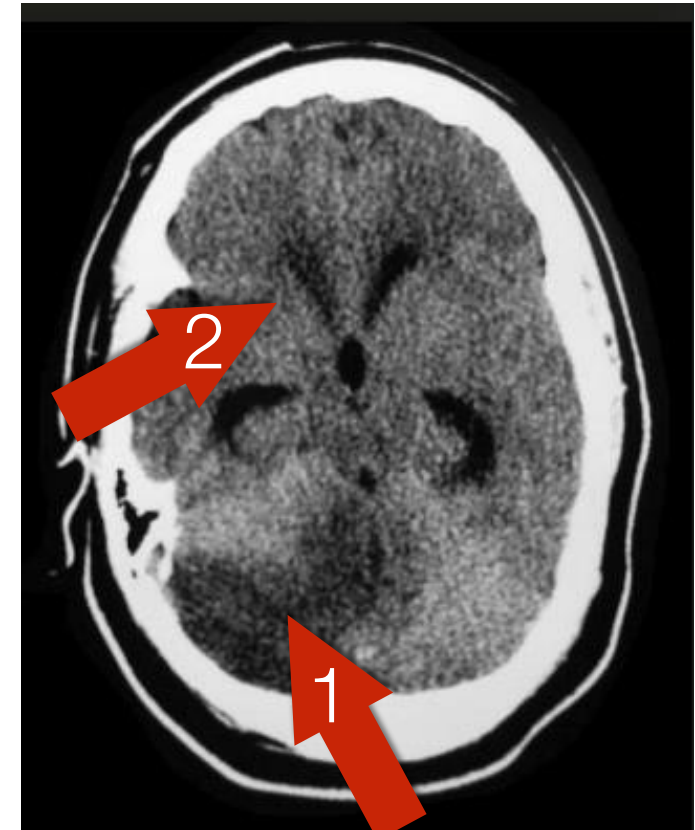
Indications for placement of EVD



Subarachnoid Hemorrhage (1) with hydrocephalus (2)



Intracerebral hemorrhage (1) with ventricular extension (2)



Cerebellar stroke (1) with hydrocephalus (2)

Hemorrhage

Intracerebral hemorrhage, tract hematoma or tract hemorrhages (0-41%)

Neuraxial hematoma (0-3.2%)

Neural injury

Infection (0-28% EVD)

Malposition

Occlusion and malfunction

Overdrainage of CSF

Subdural or epidural hematoma

Re-bleeding from a ruptured cerebral aneurysm

Intracranial hypotension

Cerebellar tonsillar herniation

Paradoxical herniation

Pneumocephalus

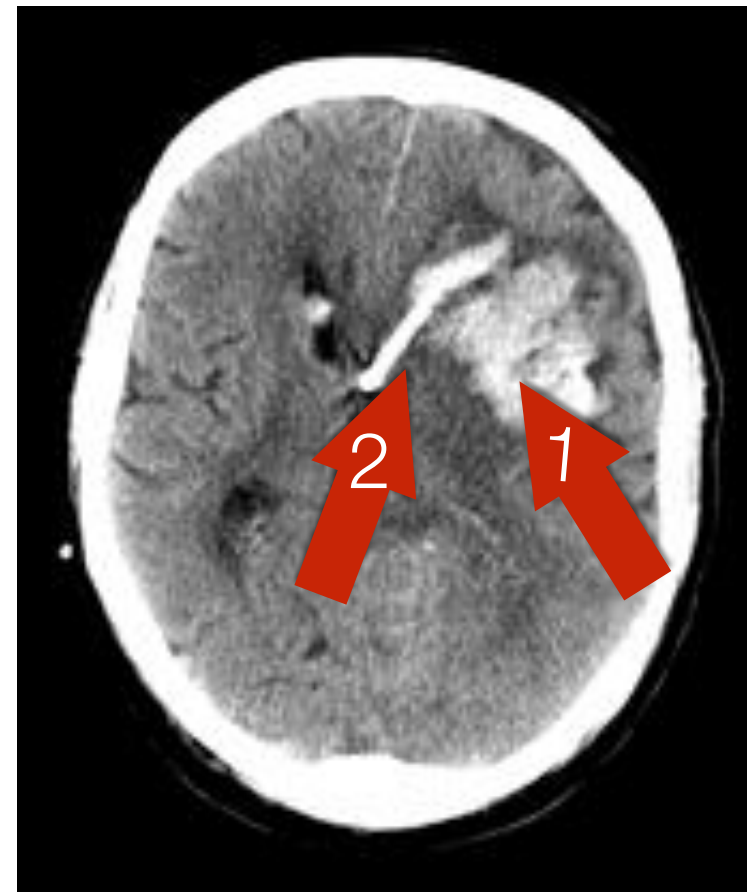
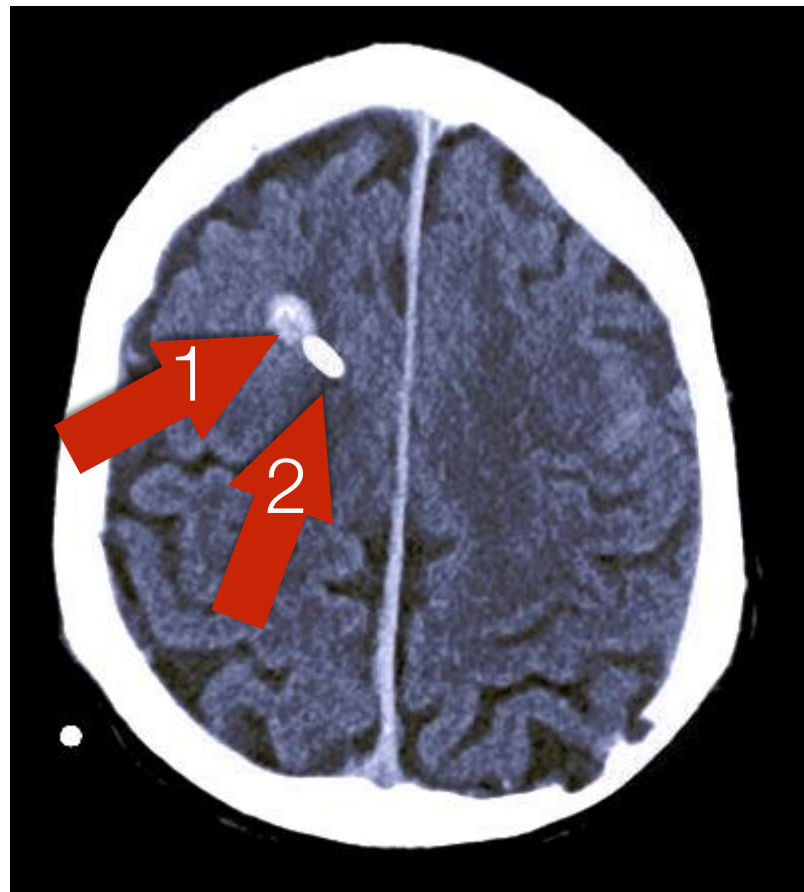
Iatrogenic vascular injury (arteriovenous fistula, cerebral pseudo aneurysm)

Fracture of catheters, with retained fragment of catheter

Inadvertent injections of drugs

Postdural puncture headache

Tractoma



Hemorrhage (1) along EVD (2) track

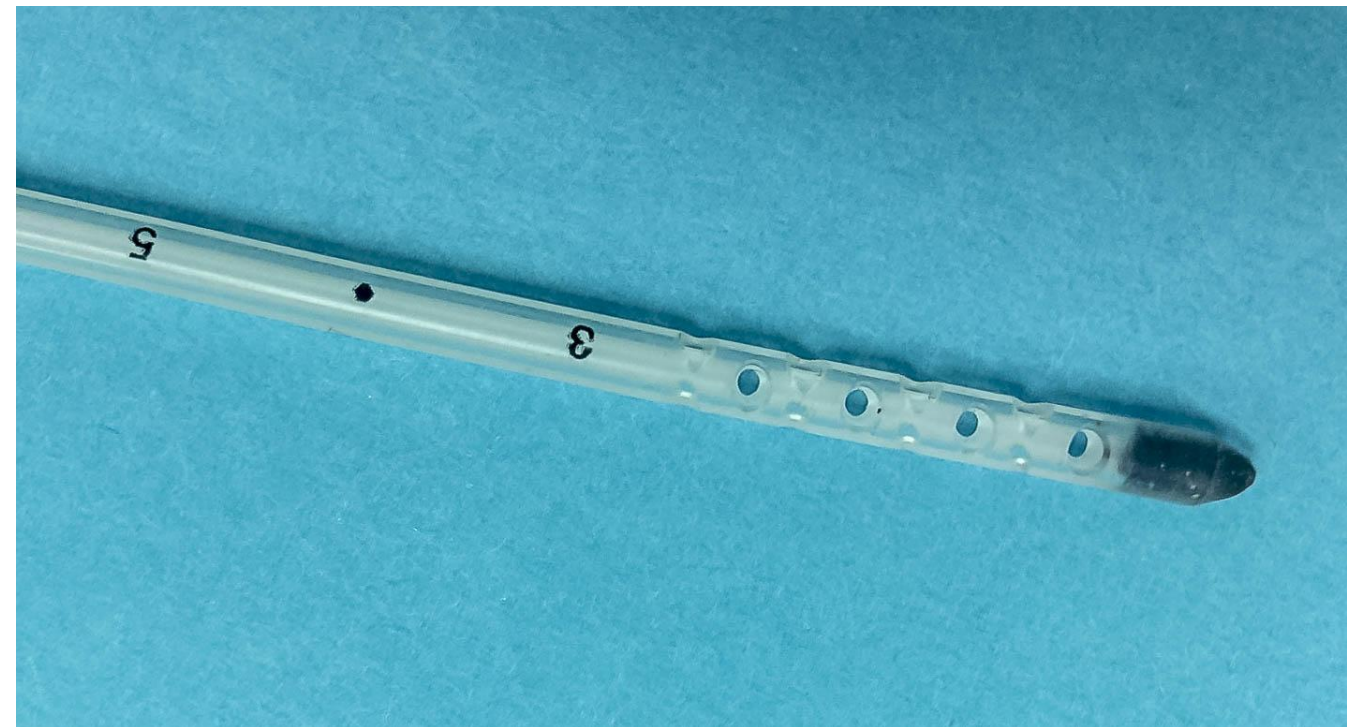
Identify Components of EVD

(1) (Type of EVD catheter)

Antimicrobial-impregnated EVD
Clindamycin and Rifampin



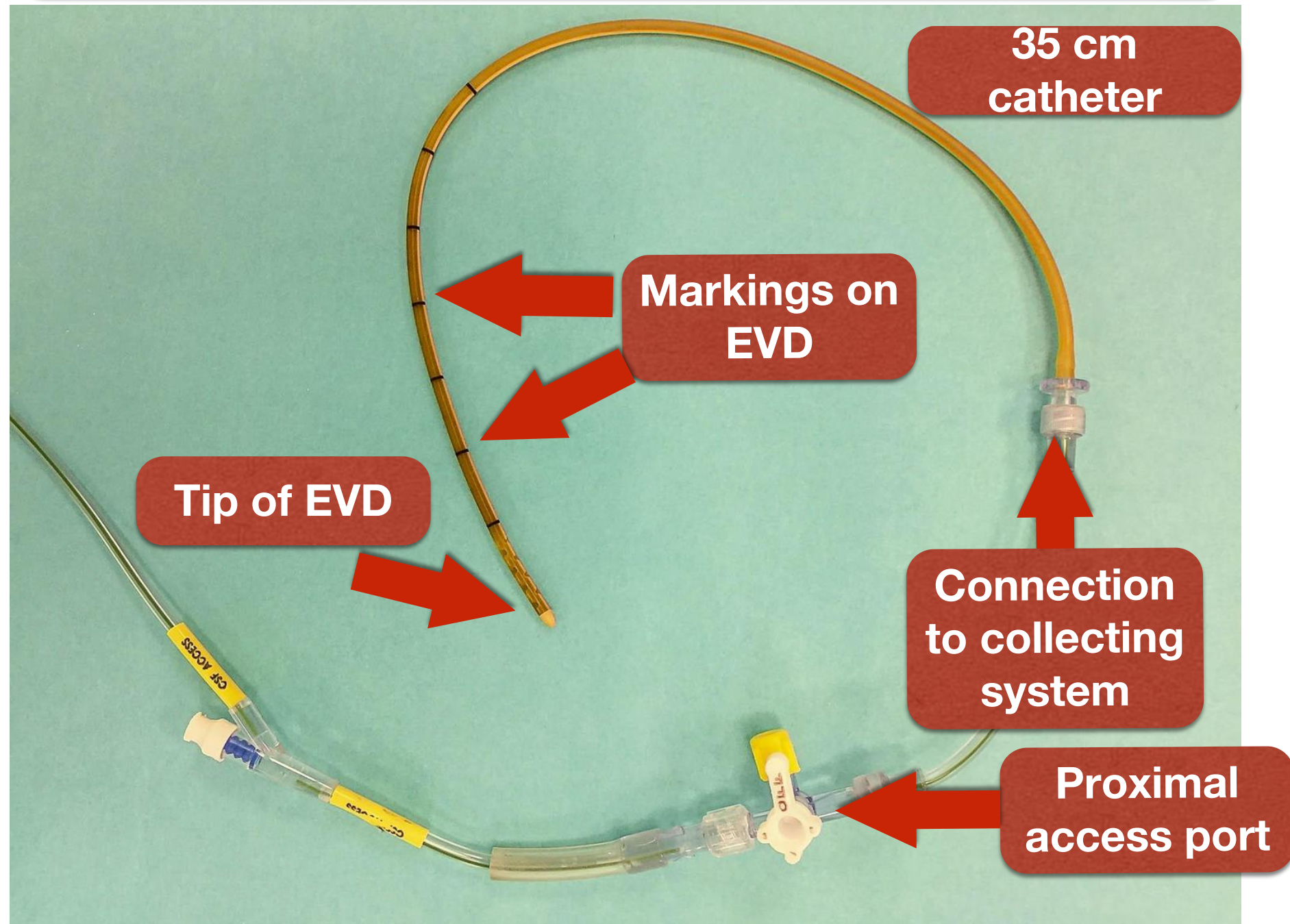
Non-antimicrobial impregnated EVD



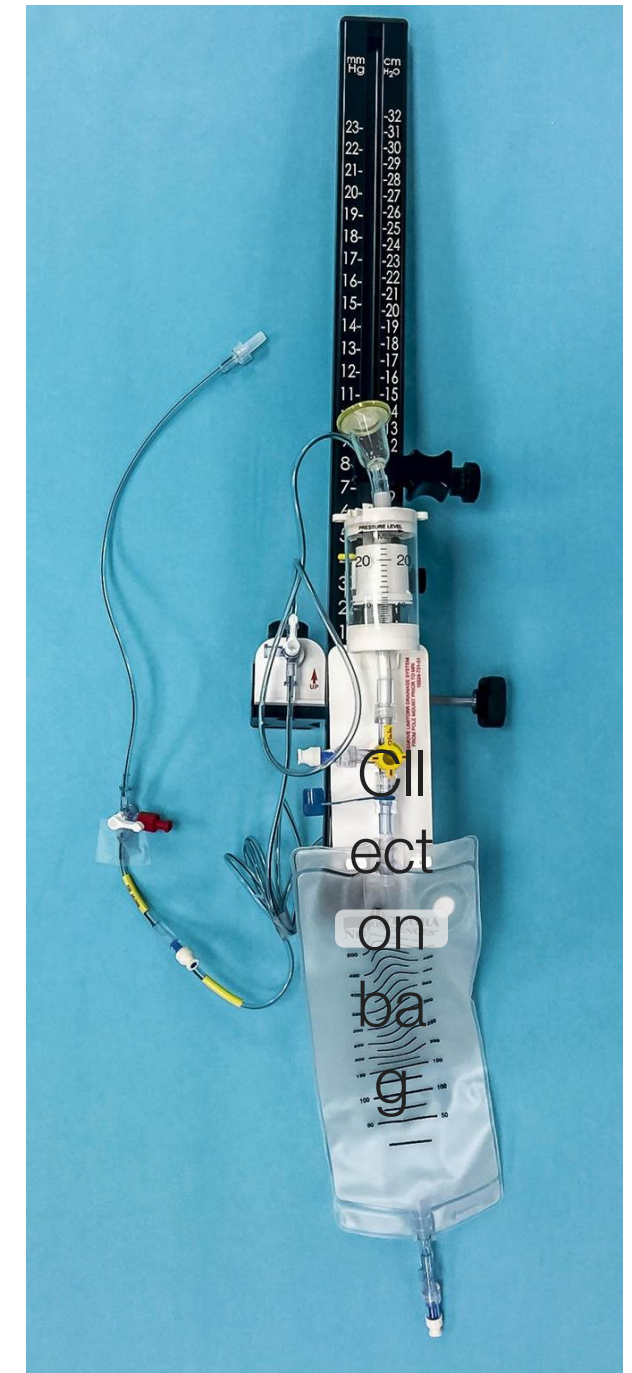
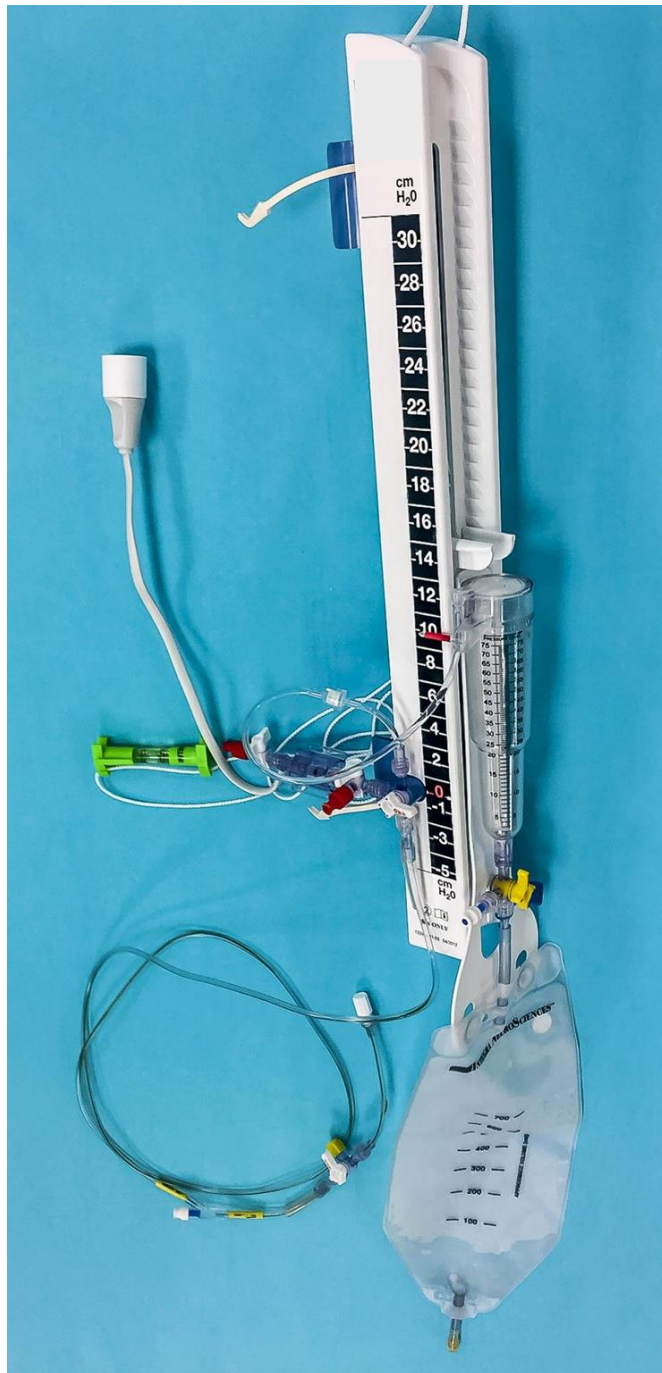
It is recommended that anti-microbial EVDs be used to reduce the risk of EVD-associated ventriculitis

Identify Components of EVD (2)

Antibiotic Impregnated EVD

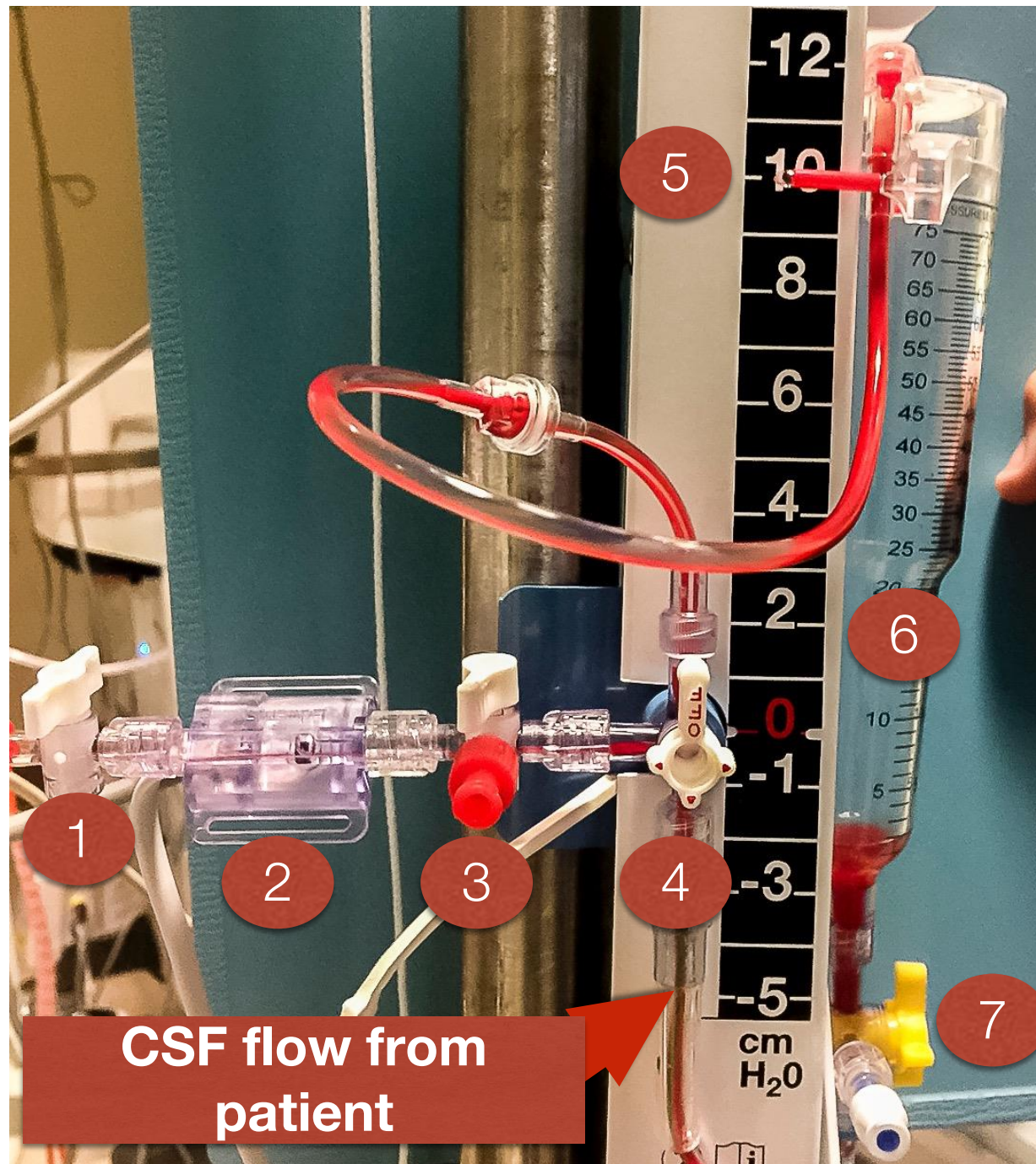


Familiarize Yourself with EVD System at Your Institution



Identify Components of EVD

(3) The Collecting System



- 1 Stopcock 1
- 2 Flushless transducer
- 3 Stopcock 2 (used to zero)
- 4 Stopcock 3 clamped to drain
- 5 EVD set at +10 cm H₂O
- 6 Graduated drip chamber* (burette) for collecting CSF
- 7 Stopcock 4 to stop flow of CSF

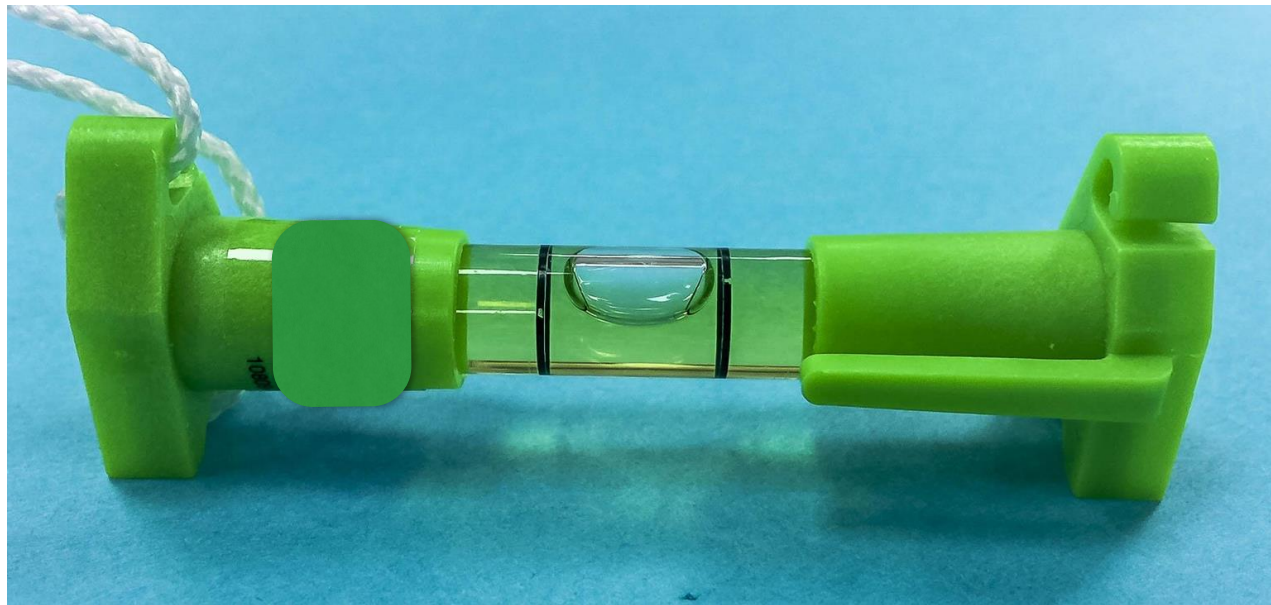
* Lowering the graduated drip chamber will increase CSF output

Device Set Up (EVD)

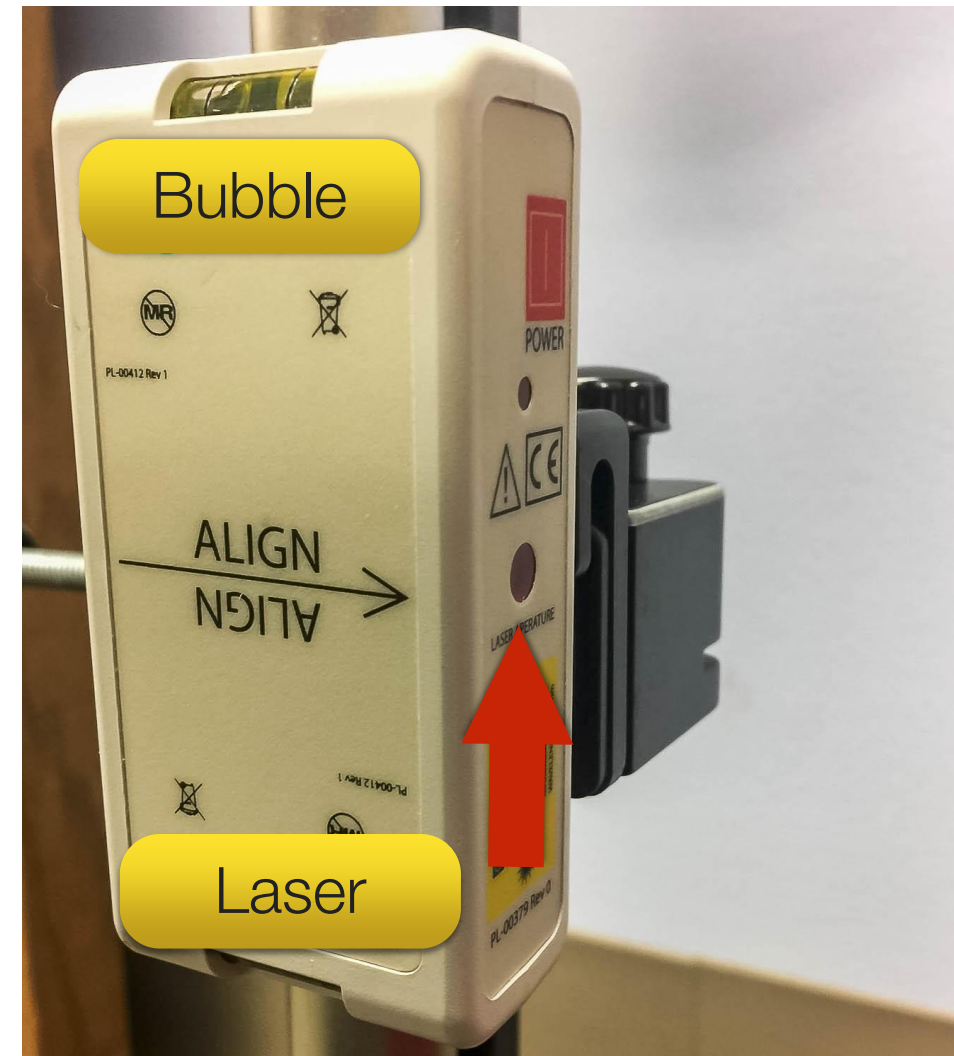
- EVD systems should be set up by personnel intimately familiar with the devices and demonstrate appropriate clinical **competency**
- Devices should be set up observing **standards** of sterile techniques
- Only **flushless transducer** systems are used
- EVD system is primed with **sterile, preservative free saline**
- **Setting** should be expressed in cm H₂O
- **Leveling** of EVD should always be made at the **external auditory meatus (EAM)**

Device Set Up

**Carpenter's Level
Bubble Level**



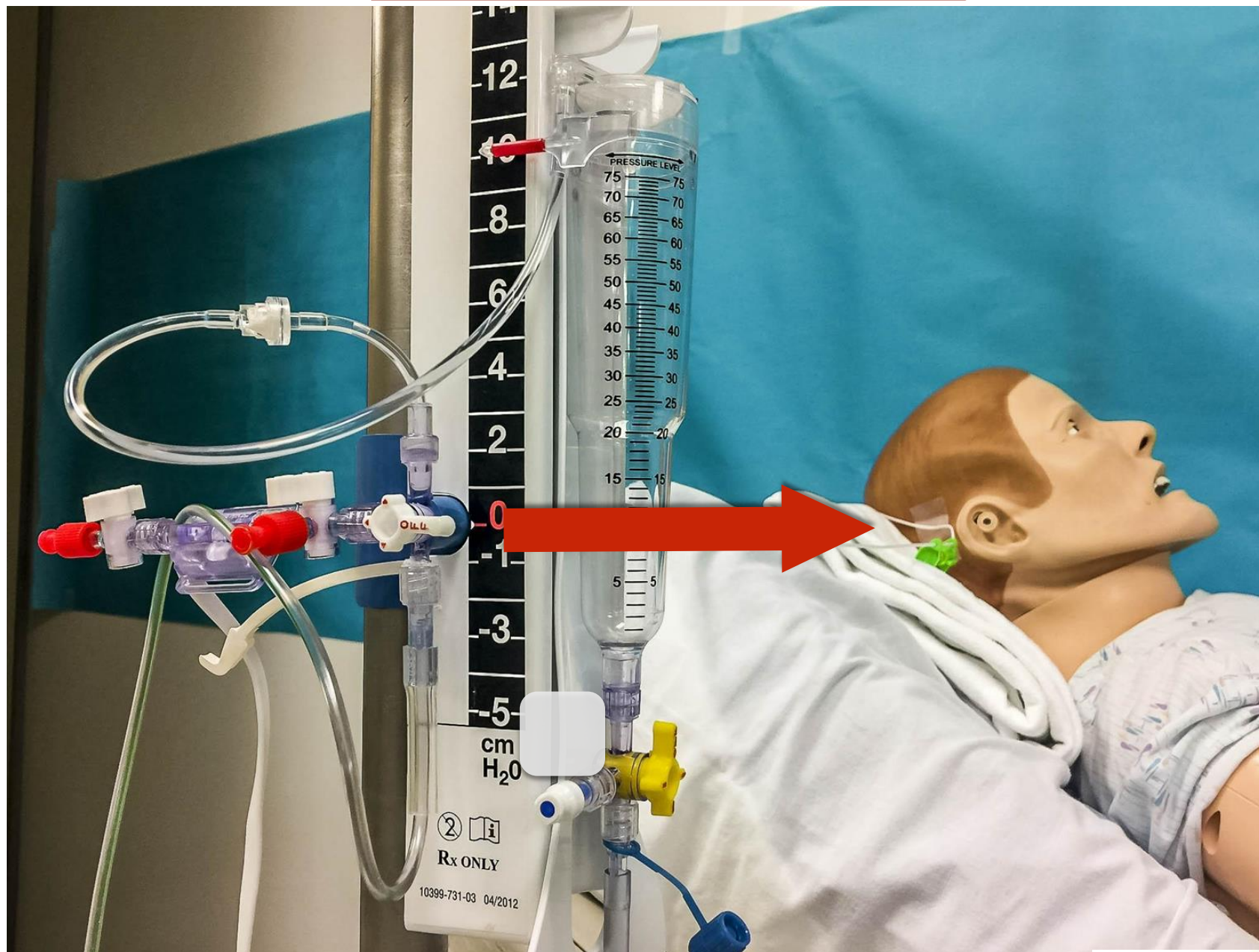
Laser Level



Device Set Up (EVD)

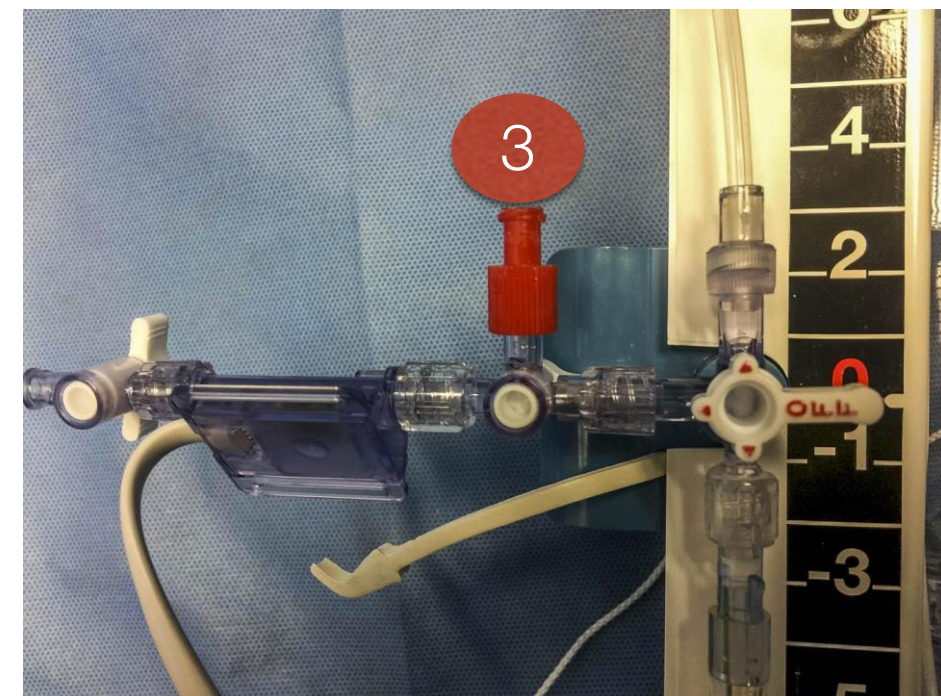
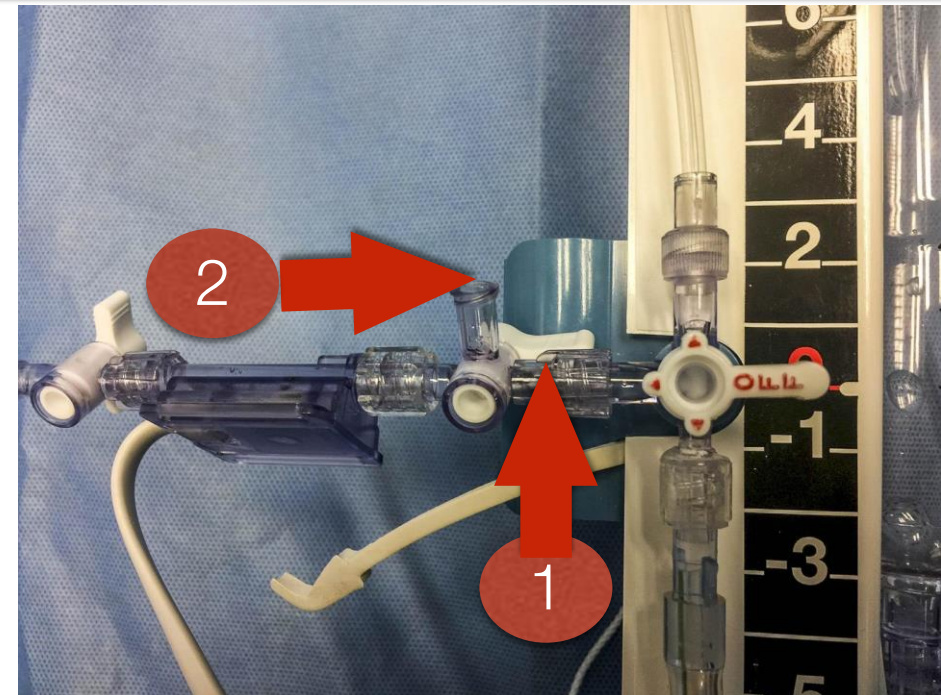
Leveling

External Auditory Meatus



Zeroing the EVD system

- Connect ventricular or lumbar catheter under **sterile** conditions
- Attach pressure cable to flushless transducer
- Turn stopcock **off to patient by turning it to “3 o’clock” position (1)**
- **Open system to air (2)** by removing the red cap
- Press “zero” on monitor
- When monitor indicates “0”, return stopcock upright
- **Replace** injection cap (3)



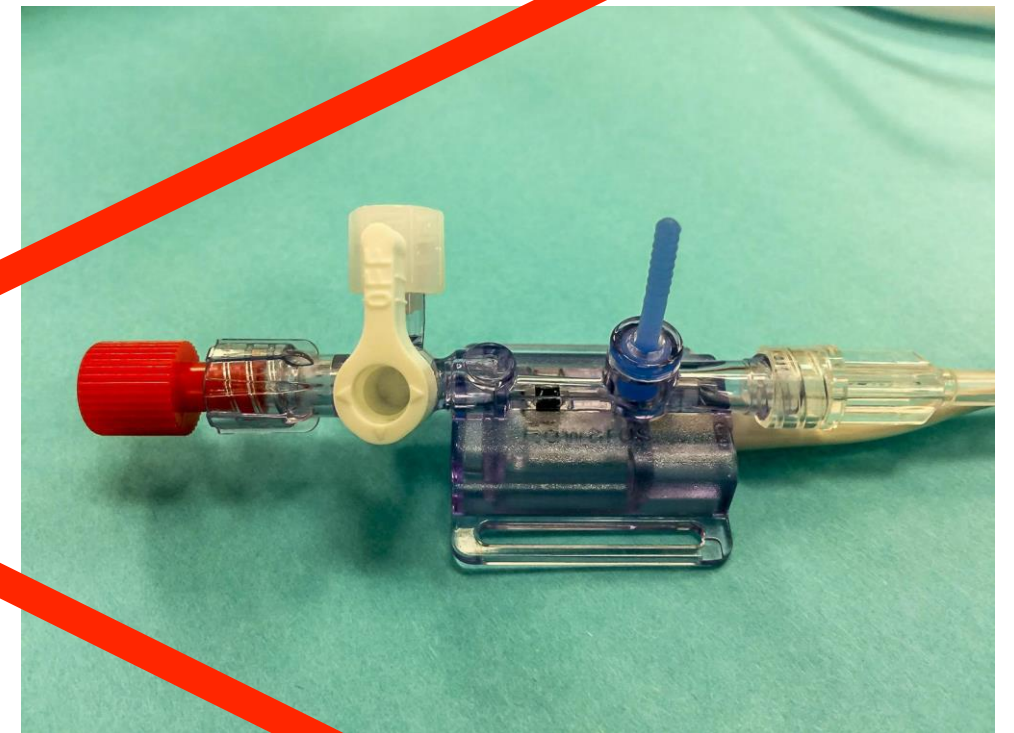
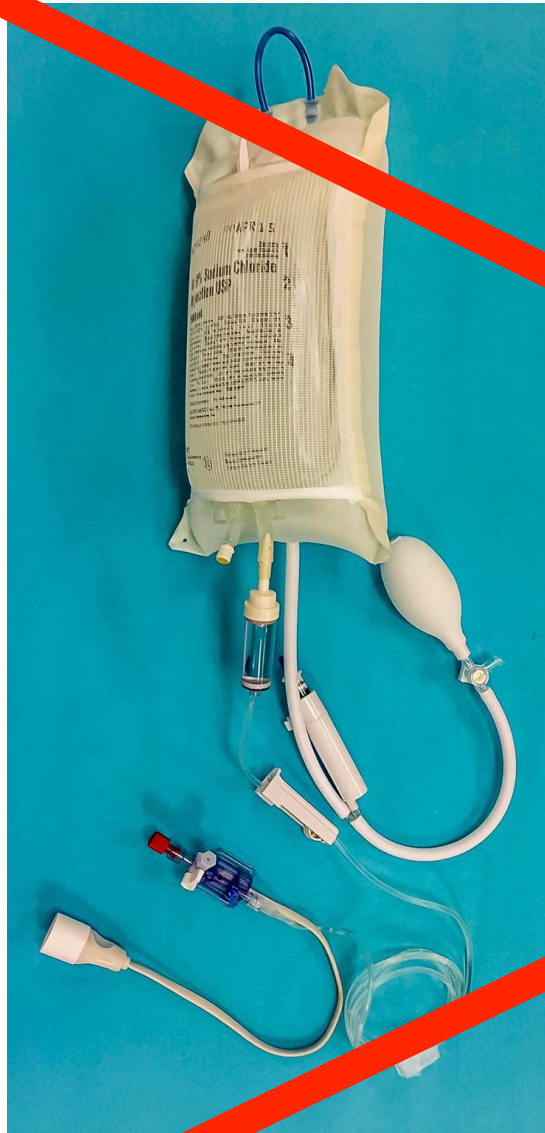
CAUTION

EVD Device Set up

EVD Device Set up

CAUTION

Do not connect EVD or LD system to a high pressure system such as pressure bag used for arterial or central venous catheter



Patient Preparation

- **Follow ASRA*** guidelines (LD) & **NCS ****guidelines (EVD) for prompt coagulopathy screening and reversal prior to EVD or LD placement and maintenance
- **Administer** antibiotics only prior to placement of EVD or LD, and follow institutional antibiograms in selecting antibiotics
- **Whenever possible** use **antimicrobial-impregnated EVDs**
- Practice **strict aseptic technique** based on national and institutional guidelines

**ASRA: American Society of Regional Anesthesia*

***NCS: Neurocritical Care Society*

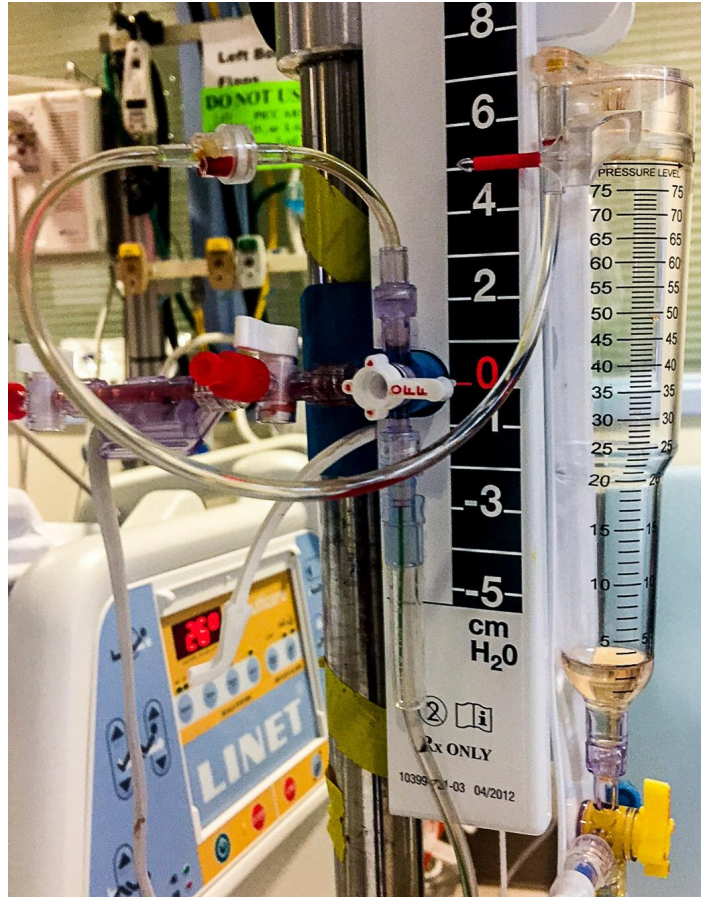
Preoperative Assessment

- Focused history and neurological examination
- CSF color and consistency
- Hourly CSF output (maximum ~ 20 ml/hr.)
- ICP values, ICP waveform analysis, ICP trends, autoregulation indices, CPP and other multimodal monitoring data as appropriate
- Clinical and radiological evidence of clamping trial tolerance

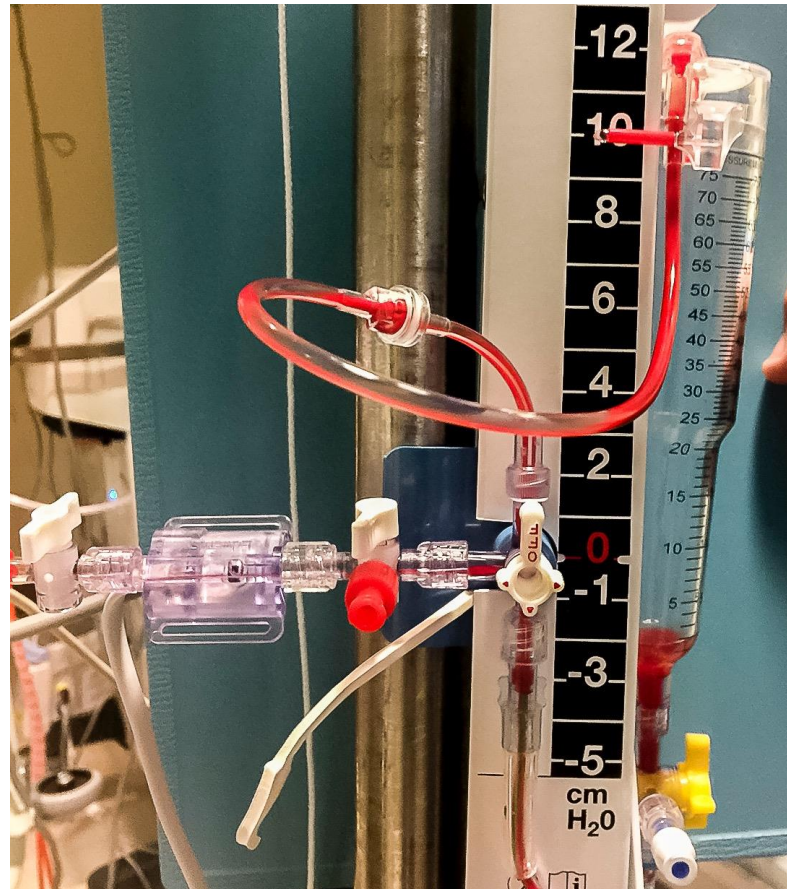
All pertinent data regarding EVD and LD may be incorporated into a pre-operative handoff between intensive care/ ward providers and anesthesia providers

Preoperative Assessment

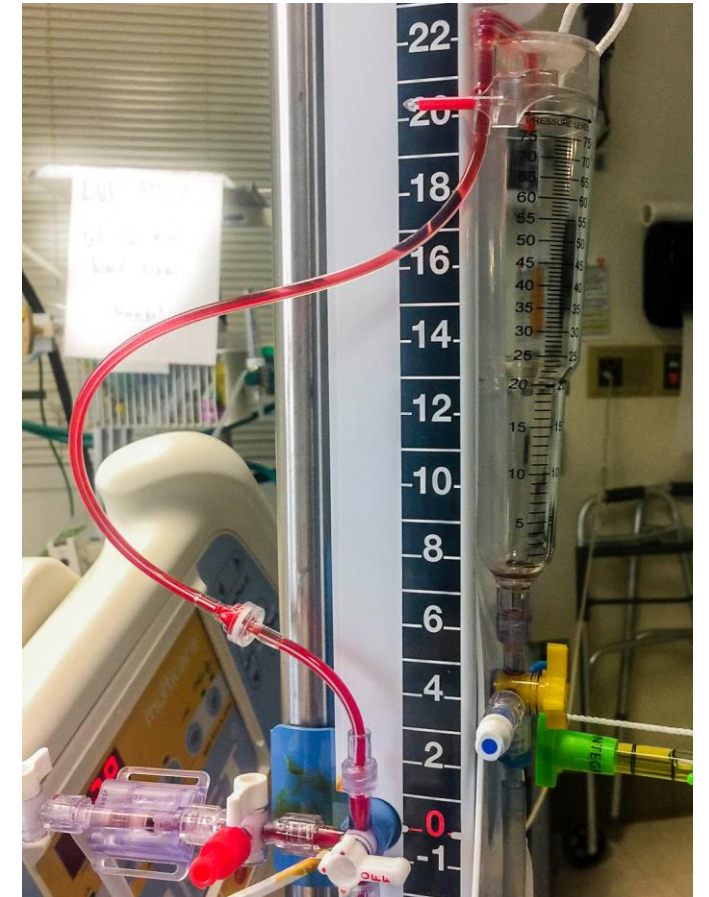
Setting of EVD



+ 5 cm H₂O



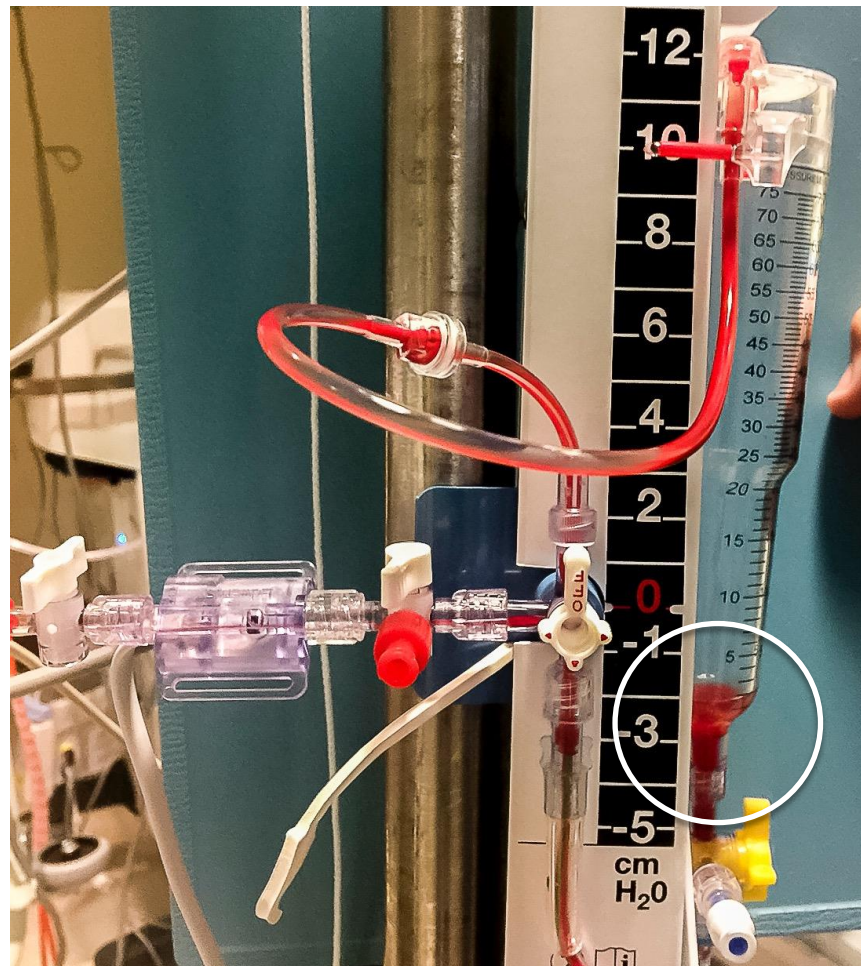
+ 10 cm
H₂O



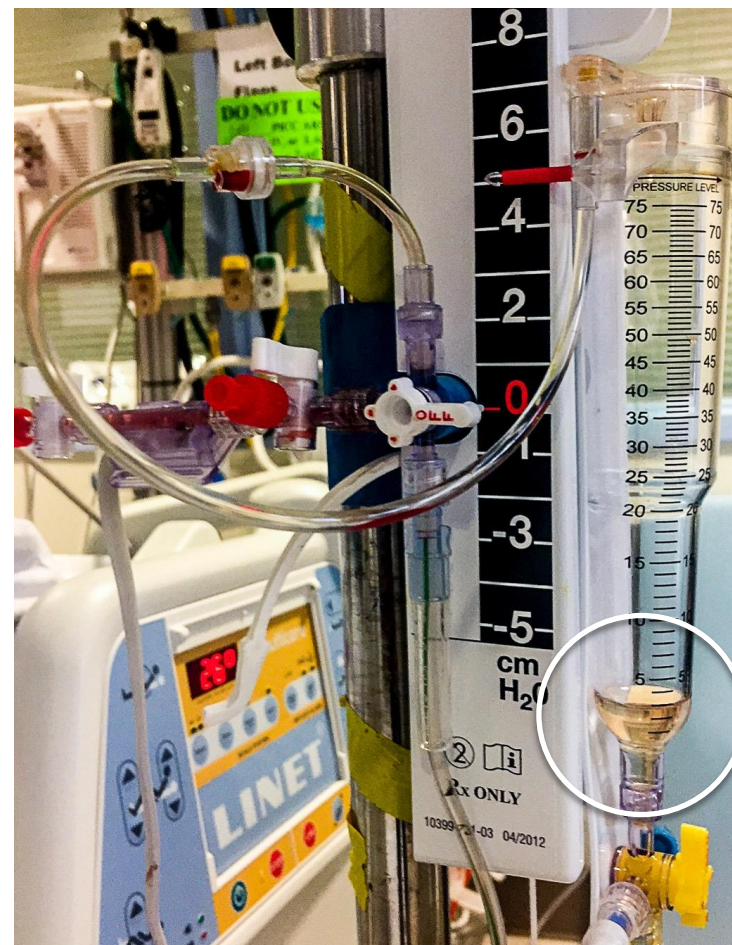
+ 20 cm H₂O

Preoperative Assessment

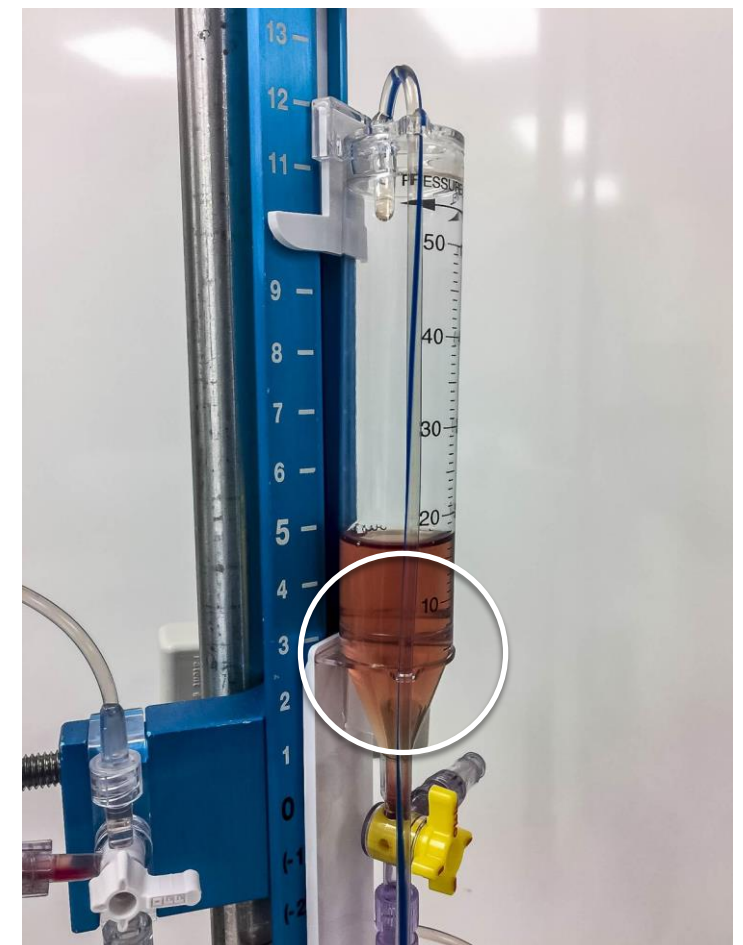
Color of CSF



Hemorrhagic (Bloody)



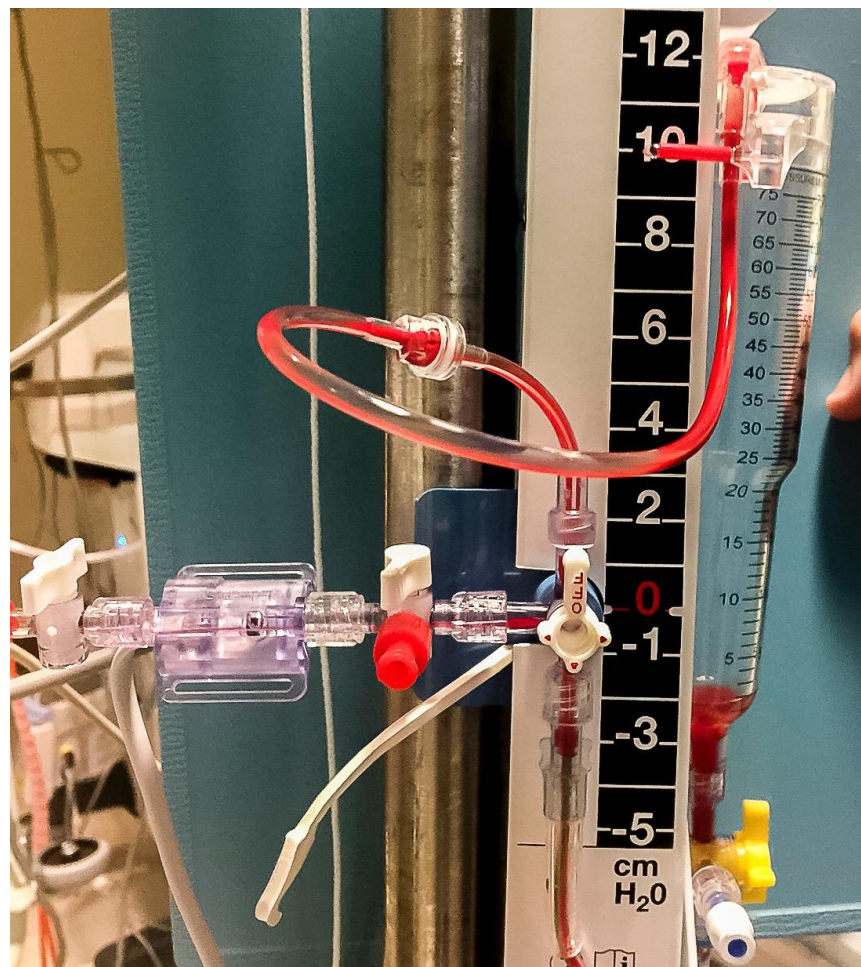
Xanthochromic



Tea-colored

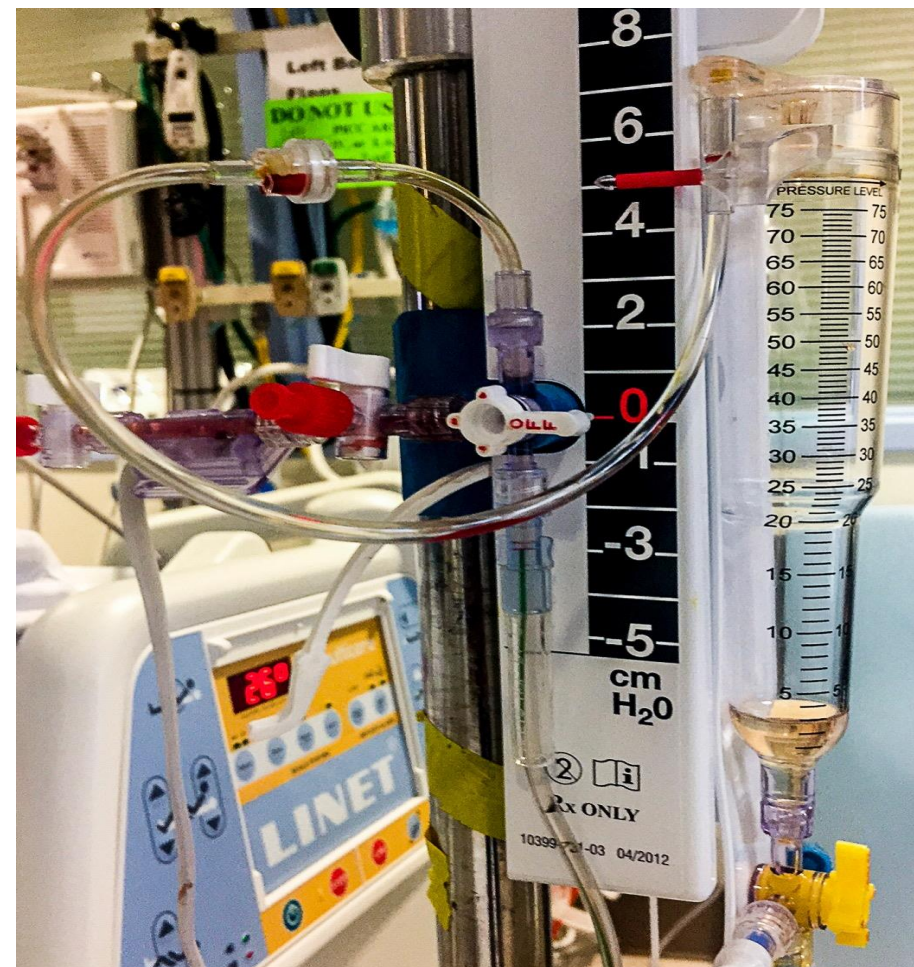
Accurate ICP Monitoring

Accurate



Stopcock at 12 o'clock

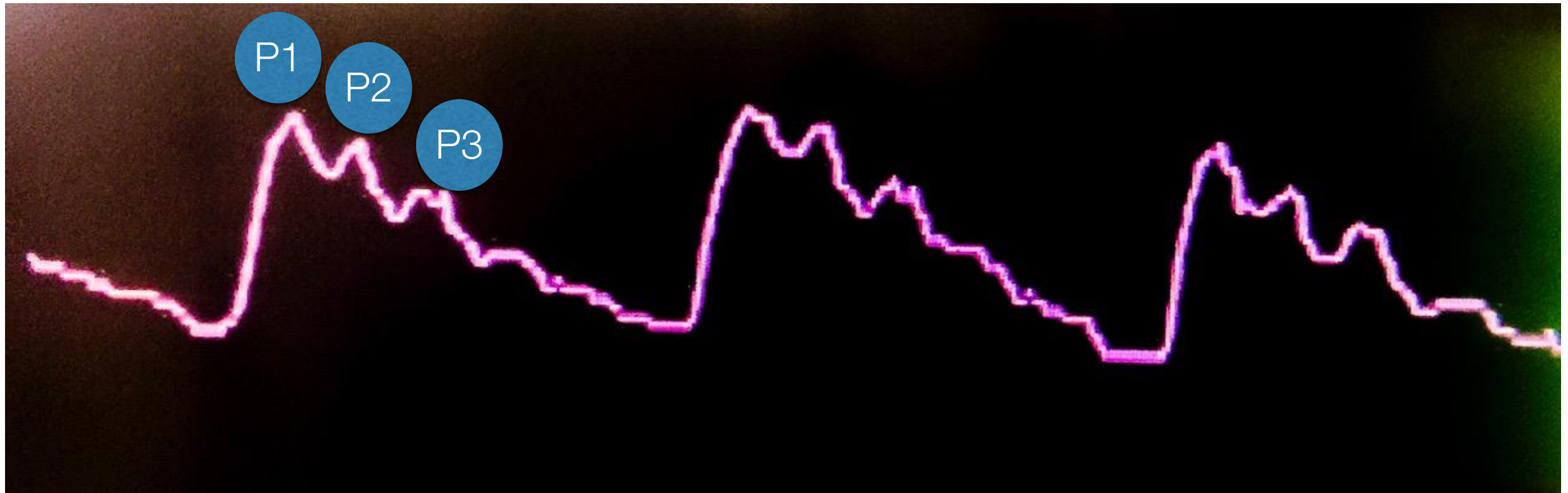
Inaccurate



Stopcock at 3 o'clock

Intraoperative Management of EVD

Normal ICP waveform



P1

Percussion wave ~ reflections off choroid plexus

P2

Tidal wave ~ brain compliance

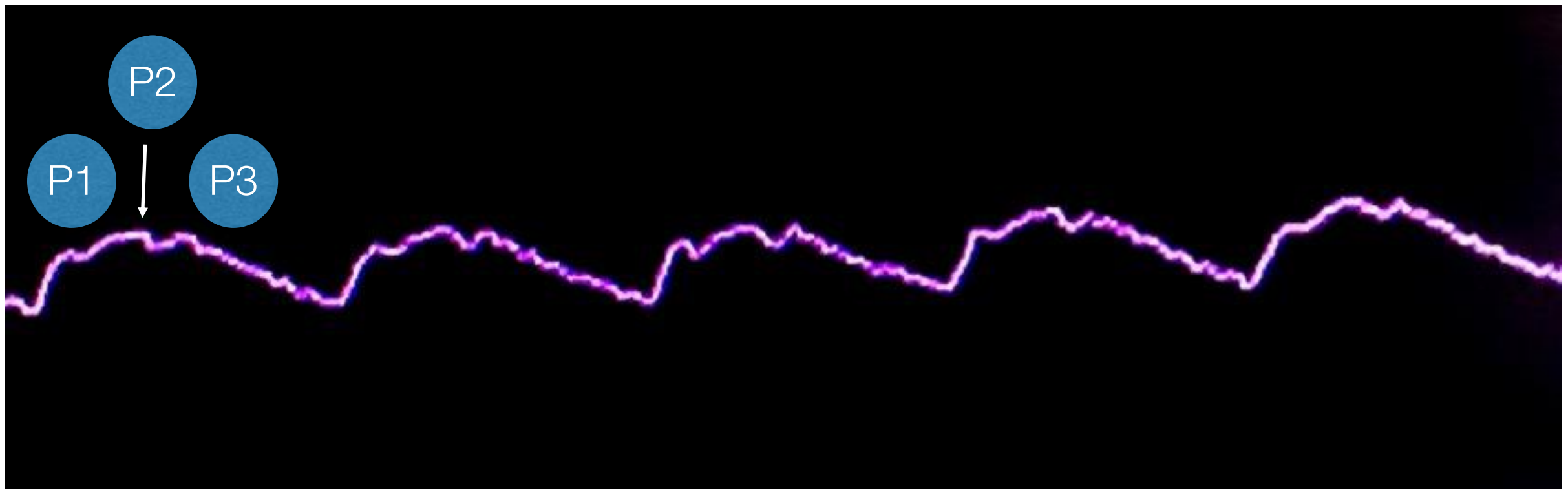
Normally P2 wave is 80% of P1 wave

P3

Dicrotic wave ~ aortic valve closure

Intraoperative Management of EVD

Abnormal ICP waveform



P2 wave is taller than P1 wave ~reduced cerebral compliance

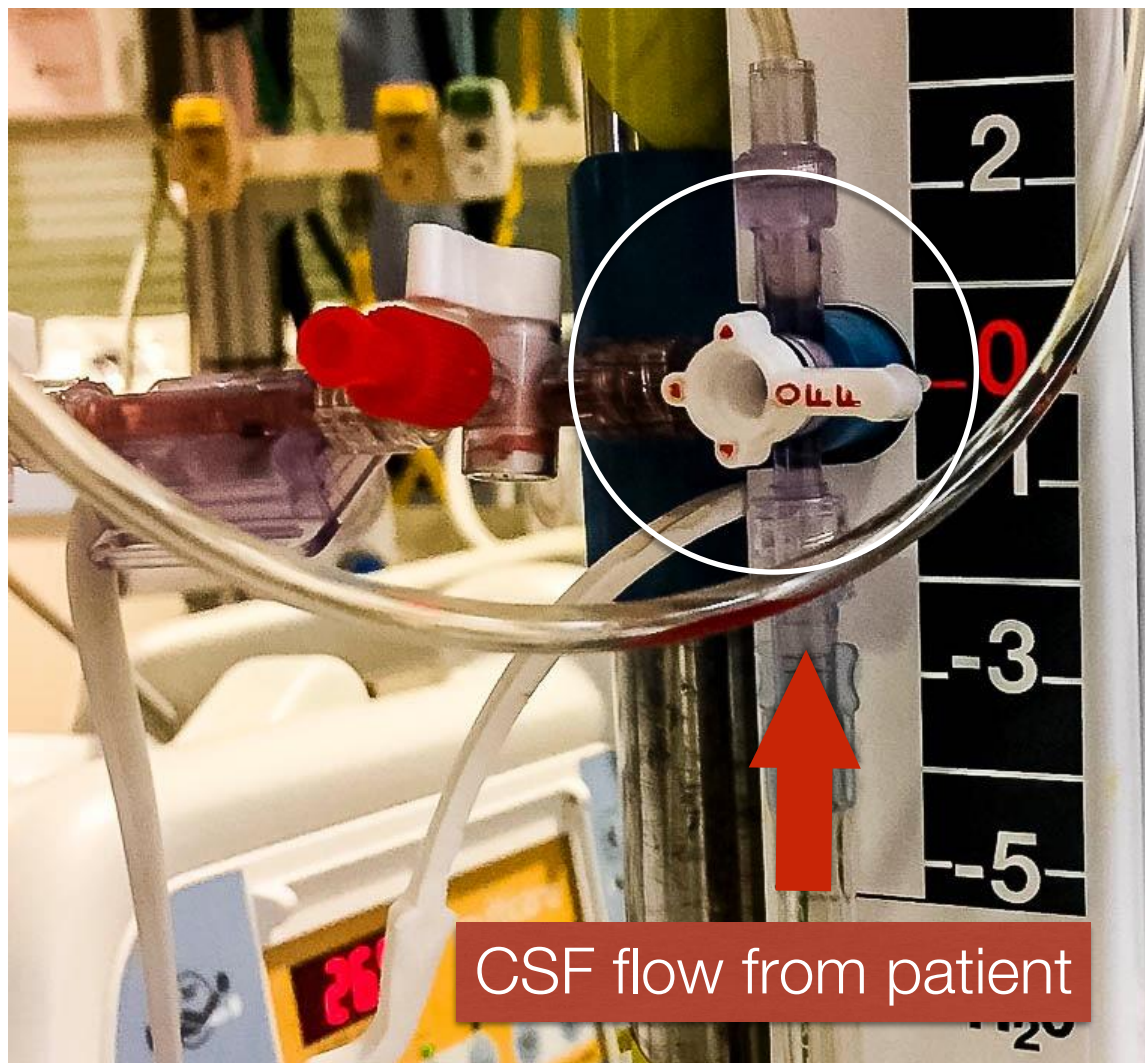
Transporting Patients with EVD

Pre-transport screening questionnaire

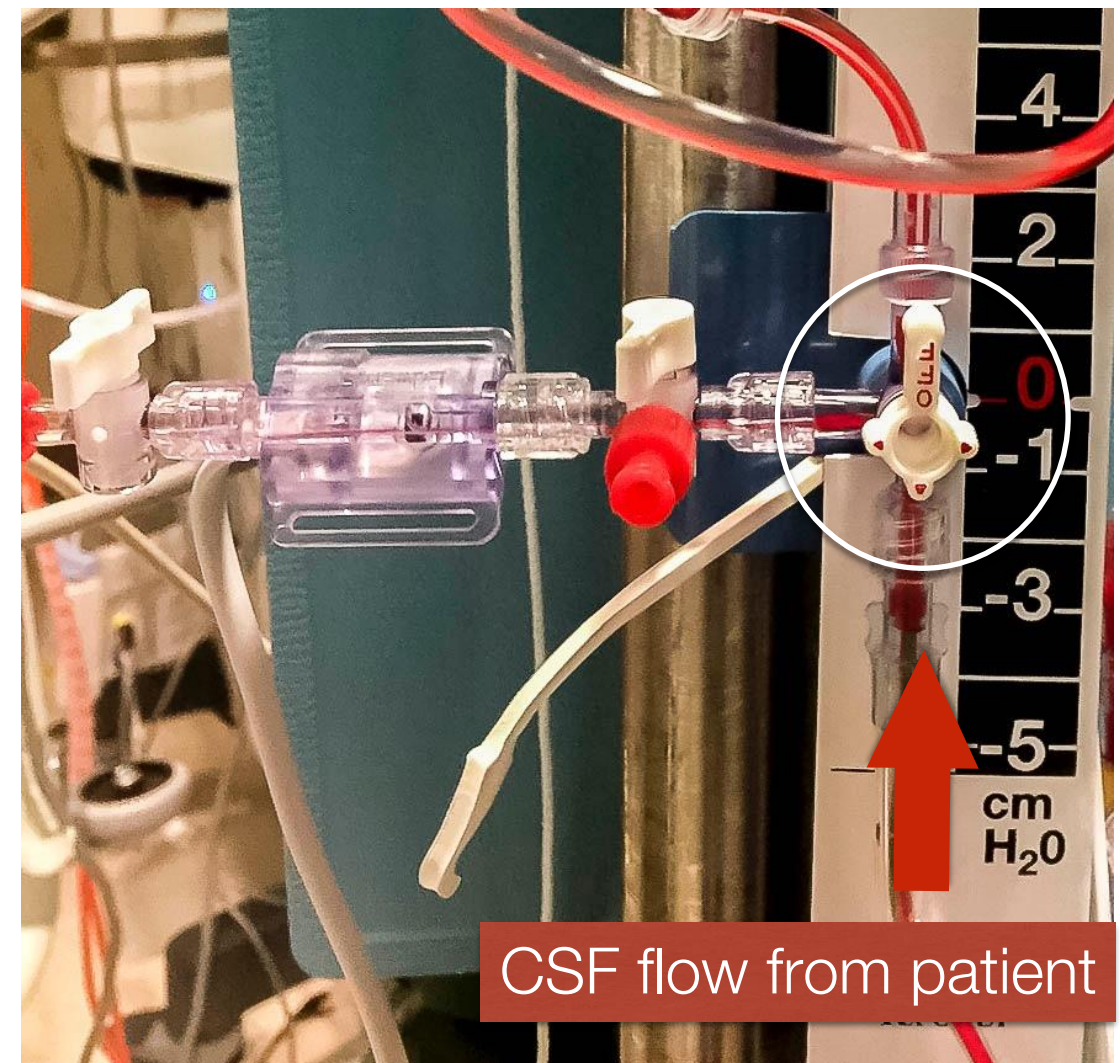
- Is EVD **continuously draining** in the neuro ICU or is it **clamped** for drainage ?
- What is **hourly** CSF drainage ?
- What is CSF **output over 24 hours** ?
- Was an **EVD clamp trial** conducted in the neuro ICU ?
- What are the results of such clamping trial ?
- What is the **baseline ICP** (< 15 mmHg, 15-19 mmHg, or > 20 mmHg)
- What is the **reason for transporting** patient to the anesthesia suite (Diagnostic vs. therapeutic procedure)

Transporting Patients with EVD

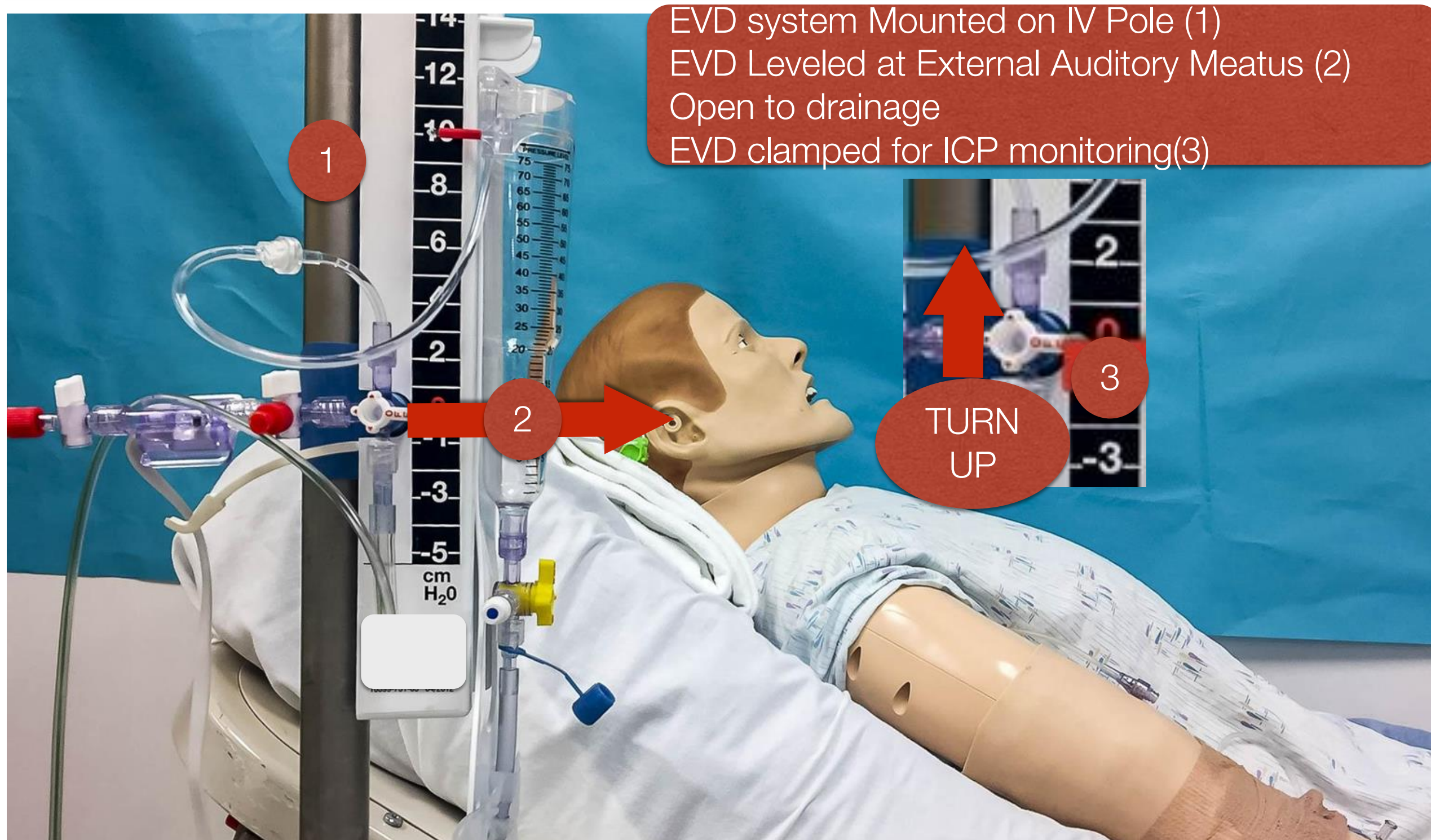
Open to drain CSF



Closed to drain CSF



Transporting Patients with EVD



Two options:

Option 1: Travel with EVD clamped

Option 2 : Travel with EVD open and draining CSF

Transporting Patients with EVD

Monitoring During Transport

- **Continue** all pre-transport monitoring and **documentation**
 - End tidal carbon dioxide
 - Mean and systolic arterial pressures
 - Intracranial pressure, brain tissue oxygenation
 - Cerebral perfusion pressure
- Use a **dedicated intravenous pole** to mount EVD and LD
- Transport **personnel be prepared** to treat intracranial hypertension during intrahospital transport
- **Individualize** decision to transport with EVD open vs. closed to CSF drainage

Intraoperative Management of EVD

- ❖ Document the following in the anesthetic record at least every hour or frequently as situation demands
 - ❖ Pressure = ICP/CPP or intraspinal pressure (ISP)/ spinal cord perfusion pressure (SCPP),
 - ❖ Amount of CSF drainage (expressed in ml),
 - ❖ Color of CSF and any change in color of CSF observed during the procedure,
 - ❖ Drain height relative to the reference level, and
 - ❖ EVD / LD status as set by the stopcocks in the device (i.e. open, clamped)
- ❖ Incorporate all information pertinent to EVD and LD into a standardized intraoperative handoff between anesthesia providers

Troubleshooting

- ❖ Promptly recognize any accidental intrathecal injection
- ❖ Lavage of intrathecal space after intrathecal injection is not recommended
- ❖ Routine flushing of the EVD should not be performed
- ❖ EVD tubing that is accidentally disconnected should be clamped immediately
- ❖ If EVD system is contaminated by disconnection, all distal parts should be replaced with new sterile tubing

Troubleshooting

ALERTS

SUDDEN CHANGE IN COLOR OF CSF

SUDDEN “DRAINAGE” OF CSF of 15-20 ML

EVD or LD SUDDENLY STOPS DRAINING

DAMPENING OF ICP WAVEFORM

Inform your attending

Inform your neurosurgeon

Perioperative Checklist

Preoperative assessment

- ☐ Obtain baseline neurological examination
- ☐ Review EVD (cmH₂O) & LD setting (in ml/hr of CSF drained)
- ☐ Review hourly CSF output to obtain baseline
- ☐ Review baseline ICP mmHg, ICP trends, and available multimodal monitoring data
- ☐ Review baseline CSF color and consistency
- ☐ Review clamp trials data if available
- ☐ Review coagulopathy profile
- ☐ Review antibiotic plan if anticipating new EVD /LD insertion in the operating room
- ☐ Provide EVD and LD details during pre-operative handoff between intensive care / ward providers and the anesthesia providers.

Transporting patients with EVD and LD

- ☐ Confirm decision to travel with EVD or LD clamp vs. open
- ☐ If travelling with EVD clamp, ensure clamping at both proximal port on EVD and distal port on CSF collecting system
- ☐ Confirm HOB status during transport
- ☐ Confirm availability of dedicated intravenous pole for EVD / LD mount
- ☐ Confirm leveling EVD at external auditory meatus & LD at phlebostatic axis or at lumbar catheter insertion site
- ☐ Enable ICP monitoring during transport
- ☐ Confirm availability of medications needed to treat intracranial hypertension during transport

Intraoperative management of indwelling drains

- ☐ Prepare transducer cable
- ☐ Identify EVD/ LD tubing by appropriate unique labeling
- ☐ Confirm HOB status during surgical procedure
- ☐ Confirm leveling of EVD at external auditory meatus & LD at phlebostatic axis
- ☐ Obtain ICP waveform & baseline ICP value
- ☐ Record q 1-hour EVD /LD setting
- ☐ Record at least q 1-hour ICP values (recorded with EVD closed to drain)
- ☐ Record at least q 1-hour EVD /LD drain output (expressed in ml)
- ☐ Provide EVD and LD details during intraoperative handoffs between anesthesia providers

Inform surgeon if any one or more of the following

- ☐ Sudden decline in CSF drainage or no drainage from EVD or LD, or occlusion of EVD or LD
- ☐ If drain output is greater than 15-20 ml at any time or in any given hour
- ☐ Sudden change in CSF color
- ☐ Dampening or loss of ICP waveform