#### Perioperative Management of External Ventricular (EVD) and Lumbar Drain (LD)

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

SNACC Task Force for Perioperative Management of EVD & LD



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# SNACC does not endorse any particular EVD or LD system manufacturer



#### **Perioperative Management of External Ventricular and Lumbar Drain**



#### 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** 

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

Treatment of vasospasm after aneurysmal SAH

Antibictics in management of central nervous system infections



#### **Indications for placement of EVD**





**Indications for placement of LD** 

Acute symptomatic hydrocephalus in SAH

Spinal cord protective strategy in open and endovascular thoracic aortic repair for

patients at high risk of spinal cord injury

Active CSF leak (due to craniofacial trauma) or those at risk for CSF leak during skull

base procedures, however lumbar drains do not reduce postoperative CSF leaks

Facilitate intraoperative brain relaxation and intraoperative exposure



Hemorrhage		
Intracerebral hemorrhage, tract hematoma or tract hemorrhages	6 (0-41%)	
Neuraxial hematoma (0-3.2%)		
Neural injury		
Infection (0-28% EVD, 0-50% LD)		
Malposition		
Occlusion and malfunction		
Over drainage of CSF		
Subdural or epidural hematoma		
Re-bleeding from a ruptured cerebral aneurysm		
Intracranial hypotension		
Cerebellar tonsillar herniation		
Paradoxical herniation		
Pneumocephalus		
latrogenic vascular injury (arteriovenous fistula, cerebral pseudo aneurysm)		
Fracture of catheters, with retained fragment of catheter		
Inadvertent injections of drugs	SNACO	
Postdural puncture headache	SOCIETY FOR NEUROSCIEN	

Complications associated with placement of EVD



#### Hemorrhage (1) along EVD (2) track



#### **Differences between EVD and LD**

	EVD	LD
Intracranial pressure monitor	Yes	No ( Intraspinal pressure)
Drainage	Dependent on ICP and EVD setting	Typically drain pre- determined amount every hour
Leveling	External auditory meatus	Phlebostatic axis OR catheter insertion site



#### **Perioperative Management of External Ventricular and Lumbar Drain**



# Identify Components of EVD (1) (Type of EVD catheter)

Antimicrobial-impregnated EVD Clindamycin and Rifampin

#### Non-antimicrobial impregnated EVD







# **Identify Components of EVD (2)**

#### **Antibiotic Impregnated EVD**





### Familiarize Yourself with Different EVD Systems









# Identify Components of EVD (3) The Collecting System



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# **Identify Components of LD**





#### **Perioperative Management of External Ventricular and Lumbar Drain**



### **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 H20 Leveling of EVD should always be made at the **external auditory meatus (EAM)** 



### **Device Set Up**

#### Carpenter's Level Bubble Level









# **Device Set Up (EVD)**

#### Leveling

#### **External Auditory Meatus**





# **Device Set Up (LD)**



### **Device Set Up (LD)**

LD 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 LD system is primed with **sterile, preservative free saline Leveling** of LD can be made at the external auditory meatus (EAM), level of catheter insertion or at the phlebostatic axis by use of Carpenter's bubble or laser level



### **Device Set Up**

#### Carpenter's Level Bubble Level









# **Device Set Up (LD)**

Leveling

#### **Phlebostatic axis**



#### Leveling at catheter insertion site





#### **Perioperative Management of External Ventricular and Lumbar Drain**



### Zeroing EVD and LD 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 & LD Device Set up**



### **EVD & LD 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



#### **Perioperative Management of External Ventricular and Lumbar Drain**



### **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



#### **Perioperative Management of External Ventricular and Lumbar Drain**



### **Preoperative Assessment**

Focused history and physical examination CSF color and consistency Hourly and daily CSF output ICP values, ICP waveform analysis, ICP trends, autoregulation indices, CPP and other multimodal monitoring data Clinical and radiological evidence of clamping trial tolerance

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



### **Preoperative Assessment**

#### **Setting of EVD**



#### + 5 cm H20



+ 10 cm H20



+ 20 cm H20



### **Preoperative Assessment**

#### Color of CSF



#### Hemorrhagic (Bloody)



#### Xanthochromic







### **Intraoperative Management of EVD & LD**

#### Normal ICP waveform



**Percussion wave ~ reflections off choroid plexus** 

Tidal wave ~ brain compliance

**P1** 

P2

P3

Normally P2 wave is 80% of P1 wave

**Dicrotic wave ~ aortic valve closure** 



#### **Intraoperative Management of EVD & LD**

#### Abnormal ICP waveform



#### P2 wave is taller than P1 wave ~reduced cerebral compliance



#### **Perioperative Management of External Ventricular and Lumbar Drain**



**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 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)



#### EVD open to drain CSF

#### EVD closed to drain CSF











#### **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



#### **Perioperative Management of External Ventricular and Lumbar Drain**







# Intraoperative Management of EVD & LD

#### Label EVD and LD

#### **Create Alert labels**





### Intraoperative Management of EVD & LD

Document the following in the anesthetic record at least every hourly or 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



#### **Perioperative Management of External Ventricular and Lumbar Drain**



### Troubleshooting

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



Troubleshooting



### SUDDEN CHANGE IN COLOR OF CSF

### SUDDEN "DRAINAGE" OF CSF of 15-20 ML

### **EVD or LD SUDDENLY STOPS DRAINING**

### **DAMPENING OF ICP WAVEFORM**

Call Anesthesiology attending

> Call Surgeon



#### **Perioperative Management of External Ventricular and Lumbar Drain**



# **Perioperative Checklist**

Preoperative assessment Obtain baseline neurological examination Review EVD (cmH20) & 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 CSE 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
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 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 FVD /I D drain output (expressed in mI)
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



### Question # 1

During pre-operative assessment of patient with indwelling EVD, the anesthesia provider should perform all of the following *EXCEPT* :

Perform EVD clamp trial

Focused neurological examination

Inspection of EVD system

Obtain hourly and 24-hour EVD output data

Answer a



#### Question # 2

During transporting a patient to and from the operating room, which of the following is true ?

It is ok to place CSF collecting system horizontal in the patients bed

It is required to mount CSF collecting system on an intravenous pole

It is ok not to monitor ICP during transport

It is ok to connect EVD and LD to a flushable pressure transducer system

Answer b



#### Question # 3

Which of the following is true?

Overdrainage complications are common to both EVD and LD Ventriculostomy associated hemorrhages occur in only in patients with coagulopathy

In patients with unsecured ruptured cerebral aneurysm it is ok to open EVD and rapidly drain cerebrospinal fluid

CSF output of more than 10 ml/hr is considered overdrainage

Answer a



Question # 4

During a neurosurgical procedure, you notice sudden decline in CSF output from external ventricular drain and ICP waveform is lost. All of the following are appropriate in troubleshooting, *EXCEPT* :

Examine the system for kinking or obstruction Notify neurosurgeon Flush the system using preservative free normal saline Gently lowering the EVD collecting system

Answer c



#### **Question # 5**

For accurately measuring ICP, which of the following stopcock position is appropriate?



a) Stopcock closed to CSF drain



#### Answer a

b) Stopcock open to drain CSF



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