This Presentation is Free of Commercial Bias

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

## Common Indications for placement of EVD

<table>
<thead>
<tr>
<th>Indication</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Acute symptomatic hydrocephalus</strong></td>
<td>Aneurysmal Subarachnoid Hemorrhage (SAH)</td>
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<tr>
<td></td>
<td>Intracerebral and Intraventricular Hemorrhage with decreased level of consciousness</td>
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<tr>
<td></td>
<td>Acute ischemic cerebellar stroke in concurrence with decompressive craniectomy</td>
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<tr>
<td><strong>ICP monitoring in Traumatic Brain Injury (TBI)</strong></td>
<td>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</td>
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<tr>
<td></td>
<td>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 &lt; 90 mmHg)</td>
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<tr>
<td></td>
<td>Management of patients with intracranial hypertension after TBI</td>
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<tr>
<td><strong>Malfunctioning or infected ventriculo-peritoneal shunts, and other neurological emergencies occurring due to infective, and neoplastic diseases</strong></td>
<td></td>
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<tr>
<td><strong>Facilitation of intraoperative brain relaxation</strong></td>
<td></td>
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<tr>
<td><strong>Targeted therapeutic interventions</strong></td>
<td>rTissue Plasminogen Activator in patients with IVH (efficacy and safety uncertain) and in patients with SAH</td>
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<td></td>
<td>Treatment of vasospasm after aneurysmal SAH</td>
</tr>
<tr>
<td></td>
<td>Antibiotics in management of central nervous system infections</td>
</tr>
</tbody>
</table>
Indications for placement of EVD

1. Subarachnoid Hemorrhage (1) with hydrocephalus (2)
2. Intracerebral Hemorrhage (1) with ventricular extension (2)
3. Cerebellar stroke (1) with hydrocephalus (2)
Introduction to EVD & LD

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
## Complications associated with placement of EVD & LD

<table>
<thead>
<tr>
<th>Hemorrhage</th>
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<tbody>
<tr>
<td>Intracerebral hemorrhage, tract hematoma or tract hemorrhages (0-41%)</td>
</tr>
<tr>
<td><strong>Neuraxial hematoma (0-3.2%)</strong></td>
</tr>
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<table>
<thead>
<tr>
<th>Neural injury</th>
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</thead>
<tbody>
<tr>
<td><strong>Infection (0-28% EVD, 0-50% LD)</strong></td>
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<table>
<thead>
<tr>
<th>Malposition</th>
</tr>
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<tbody>
<tr>
<td>Occlusion and malfunction</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Over drainage of CSF</th>
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</thead>
<tbody>
<tr>
<td>Subdural or epidural hematoma</td>
</tr>
<tr>
<td>Re-bleeding from a ruptured cerebral aneurysm</td>
</tr>
<tr>
<td>Intracranial hypotension</td>
</tr>
<tr>
<td>Cerebellar tonsillar herniation</td>
</tr>
<tr>
<td>Paradoxical herniation</td>
</tr>
<tr>
<td>Pneumocephalus</td>
</tr>
</tbody>
</table>

| Iatrogenic vascular injury (arteriovenous fistula, cerebral pseudo aneurysm) |

| Fracture of catheters, with retained fragment of catheter          |

| Inadvertent injections of drugs                                   |

| Postdural puncture headache                                      |
Introduction to EVD & LD

Complications associated with placement of EVD

Tractoma

Hemorrhage (1) along EVD (2) track
<table>
<thead>
<tr>
<th></th>
<th>EVD</th>
<th>LD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intracranial pressure monitor</strong></td>
<td>Yes</td>
<td>No (Intraspinal pressure)</td>
</tr>
<tr>
<td><strong>Drainage</strong></td>
<td>Dependent on ICP and EVD setting</td>
<td>Typically drain predetermined amount every hour</td>
</tr>
<tr>
<td><strong>Leveling</strong></td>
<td>External auditory meatus</td>
<td>Phlebostatic axis OR catheter insertion site</td>
</tr>
</tbody>
</table>
Perioperative Management of External Ventricular and Lumbar Drain

- Identification EVD & LD
  - Device Set Up
    - Patient Preparation
    - Leveling and Zeroing
  - Pre-op Assessment
  - Introduction
  - Indications
  - Complications
  - Transporting EVD & LD
  - Intraoperative Management
  - Troubleshooting

Perioperative Checklist

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SOCIETY FOR NEUROSCIENCE IN ANESTHESIOLOGY AND CRITICAL CARE
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
- 35 cm catheter
- Markings on EVD
- Tip of EVD
- Connection to collecting system
- Proximal access port
- 35 cm catheter
- Markings on EVD
- Tip of EVD
- Connection to collecting system
- Proximal access port
Familiarize Yourself with Different EVD Systems
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 in collection bag

CSF flow from patient

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Identify Components of LD

- **80 cm lumbar drain catheter**
  - Inner diameter 0.7 mm
  - Outer diameter 1.5 mm

- **8.9 cm introducer needle**

- **Guide wire**
  - Outer diameter 0.46 mm
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Perioperative Checklist

Society for Neuroscience in Anesthesiology and Critical Care (SNACC)
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

Laser Level
Device Set Up (EVD)

Leveling

External Auditory Meatus
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

Laser Level
Bubble
Laser
Device Set Up (LD)

Leveling

Phlebostatic axis

Leveling at catheter insertion site
Perioperative Management of External Ventricular and Lumbar Drain

Introduction

Identification EVD & LD

Pre-op Assessment

Device Set Up

Patient Preparation

Leveling and Zeroing

Indications

Complications

Transporting EVD & LD

Intraoperative Management

Troubleshooting

Perioperative Checklist
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)
EVD & LD Device Set up
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

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- Perioperative Checklist
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 H2O

+ 10 cm H2O

+ 20 cm H2O
Preoperative Assessment

Color of CSF

- Hemorrhagic (Bloody)
- Xanthochromic
- Tea-colored
Intraoperative Management of EVD & LD

Normal ICP waveform

- **P1**: Percussion wave ~ reflections off choroid plexus
- **P2**: Tidal wave ~ brain compliance
- **P3**: Dicrotic wave ~ aortic valve closure

Normally P2 wave is 80% of P1 wave.
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

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Perioperative Checklist

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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)
Transporting Patients with EVD or LD

EVD open to drain CSF

EVD closed to drain CSF

CSF flow from patient

CSF flow from patient
Transporting Patients with EVD or LD

1. EVD system Mounted on IV Pole
2. EVD Leveled at External Auditory Meatus
3. EVD clamped (proximal & distal)
4. TURN UP
5. TURN TO PATIENT
Transporting Patients with EVD or LD

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

- Identification EVD & LD
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- EVD & LD
  - Introduction
  - Indications
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Perioperative Checklist

Society for Neuroscience in Anesthesiology and Critical Care (SNACC)
Intraoperative Management of EVD & LD

Label EVD and LD

Do Not Inject

Create Labels

EVD

LD
Intraoperative Management of EVD & LD

Label EVD and LD

Create Alert labels

DO NOT INJECT
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

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Perioperative Checklist

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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

**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**

Call Anesthesiology attending

Call Surgeon
Perioperative Management of External Ventricular and Lumbar Drain

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## 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 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
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
b) Stopcock open to drain CSF

Answer a
SNACC Task Force
Perioperative Management of External Ventricular and Lumbar Drains

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