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Intrahospital Transport of Patients with EVDs: Monitor ICP and Prepare to Treat Intracranial Hypertension

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The intrahospital transport (IHT) of neurocritically ill patients, particularly those with external ventricular drains (EVDs), is a high-risk activity. Thousands of critically ill patients are moved within hospitals daily for diagnostic and therapeutic procedures. The Safe-Neuro-Transport, a survey-based study, identified variations across institutions, reflecting gaps in knowledge, policies, and procedures, especially regarding EVD management during transport (*J Clin Med* 2023;12:3183). This study underscores the fact that, while EVDs play a critical role in managing patients with acute brain injury, their care during transport often receives insufficient attention.

Unfortunately, too often a patient with an EVD is transported in and out of the intensive care unit (ICU) or the OR with their EVD clamped and their intracranial pressure (ICP) not monitored (*J Neurosurg Anesthesiol* 2020;32:132-9). Guidelines from the Society for Neuroscience in Anesthesiology and Critical Care (SNACC) emphasize the importance of meticulous EVD management during IHT (*J Neurosurg Anesthesiol* 2017;29:191-10). Still, more than guidelines are needed to resolve the complexities of intrahospital transport. Personalized, patient-centered care is essential, particularly in high-risk scenarios like IHT during critical illness.

Transporting neurocritically ill patients is not routine; it is nuanced and complex, demanding the same vigilance as other critical interventions (*J Clin Med* 2023;12:7666; *Neurocrit Care* 2016;25:440-5; *Neurocrit Care* 2024;40:1083-8). A parallel can be drawn with managing a patient with tension pneumothorax – if a chest tube is clamped during transport, it could lead to life-threatening complications. Similarly, clamping an EVD during transport can provoke overt hydrocephalus. Moreover, clamping a chest tube without monitoring vital signs is akin to clamping an EVD during transport without ICP monitoring, a critical neurological vital sign. This lack of ICP monitoring removes a crucial safeguard, increasing the risk of adverse events. Therefore, careful attention is required to ensure patient safety.

The case for routine ICP monitoring during all IHTs

Routine ICP monitoring during intrahospital transport is critical for patients with EVDs. Continuous ICP monitoring allows for real-time detection of fluctuations, preventing secondary brain injury. Clinical studies on patients with ICP monitors demonstrate frequent ICP elevation during IHTs (*J Clin Med* 2023;12:7666; *Neurocrit Care* 2016;25:440-5; *Neurocrit Care* 2024;40:1083-8). The core principles of ICP monitoring with EVDs reinforce the argument for ICP monitoring. EVDs must be mounted on an intravenous pole and the flushless transducer leveled at the external auditory meatus. Keeping the cerebrospinal fluid (CSF) collecting chamber vertical avoids backflow of CSF clogging the filter and exposing patients to infectious complications. Modern transport monitors allow multiple plug-ins for pressure transducer systems, allowing ICP and cerebral perfusion pressure measurements during IHTs. While accurate ICP monitoring in patients with EVDs may require the EVD system to be closed to CSF drainage, the fact that ICP is measured permits a critical safety check. For example, if ICP is elevated during intrahospital transport, the EVD may be opened, and CSF drainage will allow the ICP to be reduced safely.

A thorough pre-transport assessment should incorporate key data points such as hourly CSF output and ICP trends. Bedside nurses obtain valuable information when clamping the EVD, which is needed for routine nursing care and mobility. The elevation in ICP during these short periods can indicate reduced brain compliance. Anesthesiologists should be aware of the results of these clamp trials and actively seek these vital data points prior to transport.

A nuanced pre-transport assessment is vital, balancing the risks of overdrainage of CSF with the dangers of ICP elevation due to EVD clamping. Overdrainage, an often vaguely defined term, can cause complications such as rebleeding of an already ruptured intracerebral aneurysm due to the widening of the transmural pressure gradient from a precipitous drop in ICP. Still, elevated ICP from clamping the EVD cannot be ignored, as it may lead to decreased cerebral perfusion. Such a nuanced understanding is necessary. This assessment should inform the decision to clamp or continue CSF drainage, ensuring the transport strategy is tailored to the patient's needs.

Best practices for IHT of patients with EVDs

To ensure safe and effective intrahospital transport for patients with EVDs, the following best practices are recommended:

1. **Pre-transport planning:**
   - The anesthesiologist should ***conduct*** a pre-transport check-in with the intensive care team, neurosurgeons, and bedside nurses to
     i. **Identify** known risk factors associated with IHT-associated increased ICP (defined as ≥20 mmHg) in patients with cerebrovascular disease (*Neurocrit Care* 2017;26:196-04):
        1. ICP≥15 mmHg before initiation of IHT
        2. High hourly CSF output before initiation of IHT
        3. Transport for a procedure such as microsurgical or endovascular repair of a ruptured intracerebral aneurysm.
     ii. **Identify** other factors that may be associated with increased ICP during IHT, such as:
        1. Failed EVD clamp trial (defined as intolerance to clamping EVD, where patient either demonstrates worsening headache, a decline in the level of consciousness, elevation in ICP, or presence of or worsening of hydrocephalus on brain computerized tomography)
        2. Recent interventions for managing ICP elevation, including hyperventilation, hyperosmolar agents, deep sedation, and analgesia
        3. ICP waveform with P2>P1 suggesting reduced brain compliance.
2. **Transport phase:**
   - **Use** a portable monitor that allows ICP monitoring
   - To support cerebral venous drainage, **maintain** head elevation (30-45 degrees) and neck in a neutral position.
   - ***Level*** the EVD at the external auditory meatus
   - ***Prepare*** to intervene should ICP elevation (22 mmHg for five minutes or more) occur. This may include opening the EVD to drain CSF, among other measures, such as hyperosmolar therapy and sedation. The anesthesiologist should carry appropriate medications for intervention during IHT
3. **Post-transport care:**
   - ***Reassess*** the patient's neurological status and verify EVD functionality upon arrival at the destination
   - ***Debrief*** to review the process, document any events, and address any issues
   - ***Report*** any adverse events to the hospital's patient safety net database.

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Implementing best practices for the transport of patients with EVDs is crucial for minimizing risks and improving outcomes. Routine ICP monitoring and a nuanced pre-transport assessment are vital for ensuring safety. Quality care during transport requires personalized strategies, considering each situation's unique challenges. Reviewing and refining hospital EVD and intrahospital transport policies is a good starting point for improving IHT practices (*J Neurosurg Anesthesiol* 2022;34:21-8). Ensure these policies are clear, concise, and actionable without being overly complicated. Ensure that the hospital IHT policy calls for routine ICP monitoring. Continued research and refinement of protocols, as emphasized by the ongoing EVD Safety Campaign, will further strengthen neurocritical care practices and enhance patient outcomes (asamonitor.pub/3Vy65ql; asamonitor.pub/3B8e59K). ■

Disclosure: *Dr. Lele is a Medical Advisor for LifeCenter Northwest.*