Advanced Digital Extra-Ventricular Drain (DEVD) with Data Analytics Integration
Rodney C. Daniels, MD1,2,3; Michelle Yi4; Ankith Udupa3; and Ashwin Belle, PhD3,5

University of Michigan, Ann Arbor, MI: 1 Pediatric Critical Care Medicine; 2 School of Engineering – Biomedical Engineering; 3 Michigan Center for Integrative Research in Critical Care (MCIRCC); 4 Computer Science and Electrical Engineering; 5 FifthEye, Inc.

BACKGROUND & PROBLEM

- Accurate ICP monitoring is essential in the treatment of TBI, and the use of EVDs in these patients may also improve survival.
- The ability to accurately measure ICP and respond to critical ICP values, while quantifying and regulating CSF drainage during changing patient conditions would be invaluable.
- Current methods for monitoring pressure and CSF flow are primitive and labor intensive, requiring manual adjustments by hand.
- Current EVDs also cannot account for changes in patient position or condition and can become inaccurate, with no way to report, display, or store data from the device.
- Unintentional secondary brain injury may result from unexpected pressure/flow changes if not recognized and compensated for quickly.
- Figure 1 shows current EVD systems and the manual adjustments that must be made by hand. All volumes/flow rates are gauged by approximation. If patient position changes, the EVD is not accurate.

SOLUTION & INNOVATION

- An advanced DEVD System capable of monitoring and regulating pressure and flow continuously via real-time feedback and user inputs with sensor server integration for data management.
- At critical values of ICP, the DEVD system can automatically open EVD flow and allow immediate reduction/response to high ICP.
- The system could also adjust EVD pressures and flow to appropriate levels in response to changes in patient position, providing early warnings and alerts to changing patient condition.
- The Advanced DEVD includes a wireless interface displaying continuous data and data analytics output while allowing user input.
- This system could reduce additional demands on caregivers and provide enhanced safety against potential secondary brain injury.

ADVANCED DIGITAL EVD SYSTEM

- The Advanced DEVD is a self-contained system users can attach to any current EVD, and can link to a sensor server (Fig 2) where real time data can be stored and/or displayed via an interactive user interface (Fig 4).
- The sensor server also allows DEVD data to be utilized for calculating critical indexes used in patient care (e.g. PRx) and for use in advanced analytics, including predictive algorithms that may improve TBI outcomes.
- Continuous monitoring of patient position is also performed with the aid of ultrasonic sensors, shown in (Fig 3). The DEVD can automatically adjust pressures in order to maintain optimal patient parameters in light of any new patient position.
- Our current wireless interface with interactive graphical display (Fig 4) streams real-time data, including ICP pressures, EVD flow rates, ICP waveforms, and patient position. This allows for both central and remote monitoring, never losing data in transport or between transitions of care.
- Demo Video available upon request

SUMMARY

- Current EVD systems are primitive, requiring labor intensive manual adjustments with no inherent safety features or ability to report data, which can impact patient care and strain resources, placing patients and wounded warriors at increased risk for secondary brain injury.
- Our advanced DEVD system solves these problems by allowing automatic adjustments at critical pressure/flow values while continuously monitoring and streaming data wirelessly to an interactive user interface and sensor server that enables advanced data analytics.