ICU
MANAGEMENT & PRACTICE

Monitoring and ICP-Driven Therapies in TBI Using nICP Systems

Intracranial hypertension after traumatic brain injury (TBI) leads to secondary brain damage, high mortality, and poor outcomes. Invasive intracranial pressure (ICP) monitoring using intraparenchymal or intraventricular systems is the gold standard for guiding TBI treatment. The Seattle International Severe Traumatic Brain Injury Consensus Conference (SIBICC) developed a management algorithm with 18 interventions in escalating tiers. However, the use of invasive ICP monitoring varies worldwide, with limited adoption in low-income regions due to cost and availability. Some patients also have contraindications for invasive monitoring.

The Benchmark Evidence from South American Trial—Treatment of Intracranial Pressure (BEST-TRIP) trial found no significant difference in outcomes between patients managed with invasive ICP monitoring versus clinical and imaging-based protocols (ICE). However, the trial was not powered for specific neurological outcomes. The SYNAPSE-ICU study showed wide variability in ICP monitoring across countries and suggested potential benefits in severe cases. As an alternative, the CREVICE protocol was developed for TBI management when invasive ICP monitoring is unavailable, relying on clinical and neuroimaging findings.

Non-invasive ICP (nICP) monitoring methods, such as transcranial Doppler ultrasonography, optic nerve sheath diameter measurement, and automated pupillometry, are practical bedside tools, especially in resource-limited settings. While these methods are not yet accurate enough to replace invasive monitoring, they can help identify or rule out intracranial hypertension.

The Brussels consensus for non-invasive ICP monitoring (the B-ICONIC consensus) aims to provide recommendations and algorithms for using nICP methods in TBI cases where invasive monitoring is unavailable. A panel of 41 experts in nICP monitoring for TBI care conducted three scoping and four systematic reviews with meta-analysis to summarise global evidence.

The panel provided 34 recommendations (30 strong in favour, two strong against, and 2 weak). They emphasised that no nICP tool is accurate enough to replace invasive methods, but these tools are bedside-accessible, low-cost, and useful for estimating nICP. Limitations include technique variability, the need for training, and potential observer differences, especially with optic nerve sheath diameter (ONSD) and transcranial Doppler (TCD). Experts recommended using at least two concordant nICP methods alongside clinical and neuroimaging findings for therapeutic decisions. Serial or continuous measurements were advised to track trends, prioritising the worst values if differences exist between cerebral sides. While traditionally used for severe TBI, nICP methods may also help in moderate TBI with evolving intracranial lesions, extracranial injuries, or severe TBI with a negative CT scan.

This consensus provides recommendations and algorithms for TBI management in cases where invasive ICP monitoring is indicated but unavailable. However, invasive methods remain the gold standard and should always be prioritised when possible. nICP tools cannot provide exact ICP values but can help exclude or suspect intracranial hypertension and assess cerebral dynamics. Their use has increased, particularly in low- and middle-income countries, due to their accessibility, repeatability, and low cost.

Each nICP method has accuracy limitations and should be used in combination to improve the predictive value. Pupillometry (NPi) showed the lowest performance and should always be paired with another tool. While ONSD can be measured via ultrasound and CT, CT is not feasible for repeated bedside assessments. New automated devices, like Novasignal, may enhance TCD use without technical expertise. Proper patient positioning, such as elevating the head to 30°, is recommended for consistent measurements.

The consensus is a supplement to clinical decision-making, not a medico-legal standard, as the risks and benefits of its application remain uncertain. Treatment thresholds are based on low-quality evidence, and further research is needed to validate nICP methods in clinical practice through large observational and randomised studies. Future research should refine existing tools and explore emerging technologies like Brain4care to improve nICP accuracy.

The B-ICONIC recommendations aim to bridge the gap between existing evidence-based guidelines and clinical practice in cases where invasive ICP monitoring is unavailable. They also serve as a research agenda for validating whether nICP methods can improve patient management. The experts involved have extensive experience using nICP tools and managing TBI in diverse clinical and economic settings. These recommendations are adaptable to different contexts and can be modified by individual centres based on local expertise. Additionally, they provide a foundation for future research and clinical trials.

Source: Intensive Care Medicine
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