Intracranial Pressure (ICP) and Brain Temperature Monitoring

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Overview

Intracranial pressure (ICP) monitoring utilizes devices to measure the pressure inside the skull to assist in assessing patient condition and providing appropriate treatment. ICP monitoring is commonly utilized on patients that have life-threatening, neurological emergencies.[1,2] Brain temperature can be used in conjunction with ICP monitoring to assess patient condition, however it is not always widely utilized.

There are three ways to monitor intercranial pressure:

1. **Intraventricular catheter:** An intraventricular catheter is inserted into a drilled hole in the skull and placed into the lateral ventricle of the brain in the cerebrospinal fluid (CSF). This is the most accurate method of ICP monitoring. The inserted catheter can be used to drain CSF to help alleviate high pressure measurements; however, it may be hard to place when intracranial pressure is high.[1]
2. **Subdural screw**: Used in medical emergencies where monitoring needs to be done urgently. A hollow screw is placed in the skull through the dura mater allowing a sensor to measure pressure in the subdural space.[1]
3. **Epidural sensor**: Less invasive than the other two methods; an epidural sensor is placed between the skull and dural tissue. A drawback of this method is that it lacks the ability to decrease pressure by removing excess CSF.[1]

Actions for Consideration

Partner: Identify critical and intensive care physicians, neurosurgeons, critical care nurses and directors, biomedical team, and the appropriate value analysis leaders to assess plans for ICP equipment conversions. Discuss patient specific needs. Work with biomedical engineering to understand current inventory, warranty, and service agreements .

Connect: A careful review of all product utilization to support quality of care, with an understanding of patient populations served will be crucial to conversion discussions. Collecting and reviewing physician data (product usage and cost) to discuss preferences and monitoring capabilities for all patients. Compare equipment and disposable products (features and cost), share with key stakeholders and develop strategies to manage use. Identify evidence related to specific patient population needs or products.

Communicate: Share decision and product education plan with the team, including available training and demonstrations. Leverage supplier representative and clinical team, set clear expectations for support. Robust data sharing will not only enhance discussions, but may lead to actionable conversations between peers.

HealthTrust Resources: Access the Clinical Knowledge Insights Library to find other relevant documents and toolkits with actionable information. Examples for this product include resources on product conversion, value analysis, and clinical trials.[3] Network on HealthTrust Huddle, our member community that shares ideas and seeks guidance from colleagues.[4]

Professional Society Statements and Clinical Practice Guidelines

While there are no specific guidelines regarding the use of brain temperature monitoring in conjunction with ICP there are guidelines related to the use of ICP monitoring in general. The *Brain Trauma Foundation Guidelines for Traumatic Brain Injury Management (Level II Recommendations)* updated in 2024, speak to ICP monitoring recommendations for specific patient conditions. These recommendations are summarized below, and can be found in full here.[5]

"An ICP monitor is recommended in the following situations:

- Patients with Glasgow Coma Scale score of less than 8
- An abnormal computed tomogram (CT) scan of the head
- Two or more of the following are present: patient older than 40 years, unilateral or bilateral motor posturing, and systolic blood pressure less than 90 mm Hg.
- Patients with an initial normal CT scan or with minor changes in CT images but later show features of neurologic worsening or progression on the repeat scan
- Evidence of brain swelling, eg, compressed or absent basal cisterns
- Patients with extensive bifrontal contusions independent of the neurological condition
- When sedation interruption to check neurological function is not justified, eg, respiratory failure from lung contusions and flail chest
- When the neurological examination is not reliable, eg, maxillofacial trauma or spinal cord injury
- A decompressive craniectomy is performed as a last resort for intracranial hypertension refractory to medical management
- Following craniotomy wherein there are relevant risk factors for the propagation of brain edema, eg, confounding hypoxia, hypotension, pupil abnormalities, midline shift greater than 5 mm "[5]

FDA Approval

Specific 510(k) approval for individual products can be found by searching the 510(k) Premarket Notification database and can be found here.[6]

Physician Advisor Insight

A panel of critical care and neurosurgeons within our HealthTrust Physician Advisor Network offered the following insight with regard to the use of ICP monotring.[9]

Important Features:

- MRI compatibility
- Simple and quick method of zeroing - Less tendency for ICP measurements to drift over time - Allowing concurrent CSF drainage, if necessary.
- Ease of use of waveform analysis integration

Brain temperature monitoring:

- Brain temperature monitoring is not used in all patients, occasionally used in cases of traumatic brain injury, and instances of ischemic stroke.
- If brain temperature monitoring is not incorporated in device, infrared spectroscopy radiometry ultrasound can be utilized.
- Simultaneous temperature/ICP monitoring is still underused. More research is needed to better understand of the association between fever and secondary brain injury.

Conversion Considerations:

- Additional products that may be needed if converting to a supplier without brain temperature monitoring capabilities within ICP device: noninvasive monitoring resistance temperature detectors, semiconductor based optical sensors, and infrared medium-resolution spectroscopy.

Clinical Evidence

A sampling of clinical studies reviewing the use of brain temperature monitoring in conjunction with ICP are summarized below.

- A 2021 prospective multicenter longitudinal study was conducted in Europe and Israel to understand brain temperature in relation to ICP after traumatic brain injury (TBI).[7] The study enrolled 277 patients in 21 facilities from January 2015 to December 2017, with 21 of those patients having brain temperature (BT) measured. The study found that "BT seems to have a significant impact on ICP and cerebral perfusion pressure (CPP) despite active treatment to prevent intracranial hypertension. A similar but less severe impact is seen when temperature decreases."[7]
- A 2021 retrospective study of 115 TBI patients studied systemic hyperthermia and its effect on brain injury.[8] The study found that there was no correlation with hyperthermia and worse clinical outcomes. Overall the study found "Hyperthermia was most common between days 6 and 10 following TBI, and associated with disturbances in cerebral energy metabolism but not worse clinical outcome." [8]

Summary

When considering conversion to another supplier, a careful review of all products used is necessary to understand the scope of the initiative. There is a need to determine the financial and clinical impact of change related to capital and disposable products. Engage and collaborate with your physician leaders to better understand impact of change and determine conversion strategy for impacted facilities.

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