Medical Xpress

AI-driven tool could improve brain pressure monitoring in intensive care patients

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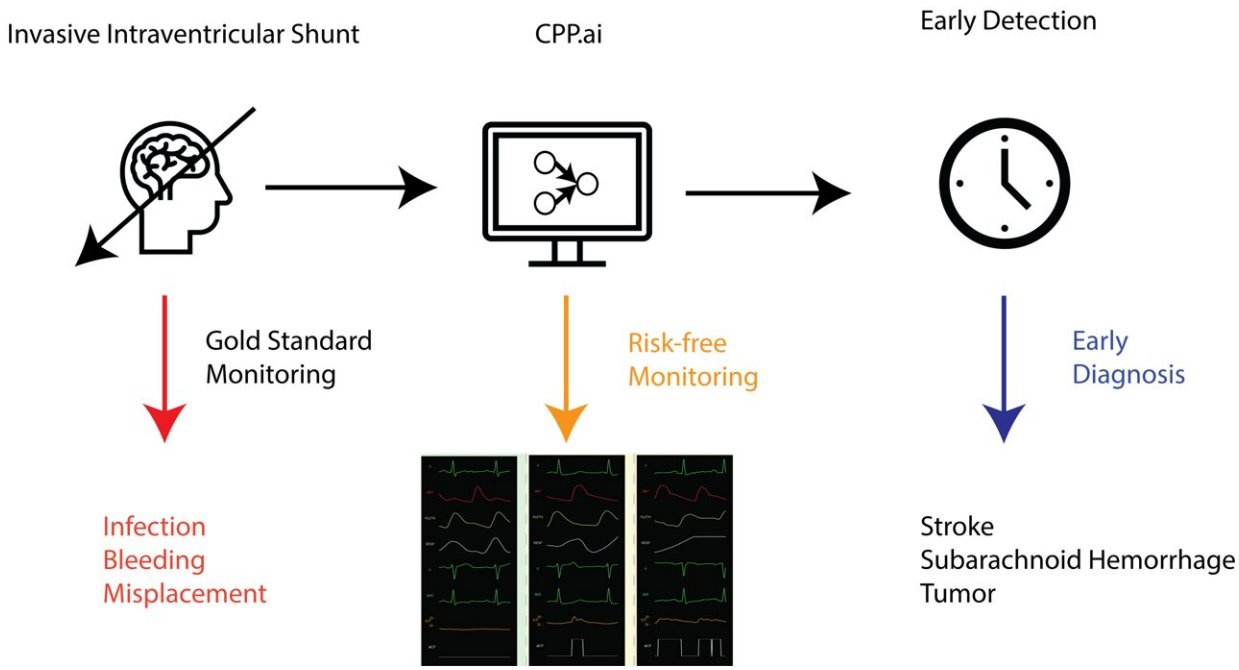

Artificial intelligence-derived intracranial pressure monitors vital information noninvasively, increasing accessibility and decreasing risk. By doing so, it could enable health care providers to intervene more quickly to save lives. Credit: Faris Gulamali and lab of Girish Nadkarni, MD, Ph.D., at Icahn Mount Sinai

Researchers at the Icahn School of Medicine at Mount Sinai have developed a noninvasive technique that could dramatically improve the way doctors monitor intracranial hypertension, a condition where increased pressure in the brain can lead to severe outcomes like strokes

and hemorrhages.

The new approach, driven by artificial intelligence (AI), offers a safer and faster alternative to the current gold standard of drilling into the skull. Details are reported in *npj Digital Medicine*.

Currently, detecting and monitoring elevated brain pressure requires invasive procedures that breach the skull. Instead, the research team explored whether intracranial pressure could be predicted by analyzing noninvasive waveform data, such as electrocardiograms, oxygen saturation levels from pulse oximetry, and waveforms obtained from routine head ultrasounds in critical care patients.

They then developed an AI model capable of generating a representation of brain blood pressure. This model was trained using de-identified patient data from those who had their intracranial pressure measured through invasive methods, such as lumbar catheters or pressure-sensitive probes inserted into the skull. The real-time monitoring tool allows for swift detection of critical changes, enabling health care providers to intervene more quickly and potentially save lives, say the investigators.

"Increased pressure in the brain can lead to a range of serious complications. We created a noninvasive approach—an AI-derived biomarker for detecting elevated brain pressure—using data already routinely collected in intensive care units (ICUs)," says first author Faris Gulamali, an MD candidate at Icahn Mount Sinai. "Importantly, our study, the largest to date on intracranial hypertension, is the first to provide external validation for our algorithm and demonstrate a direct link between the biomarker and clinical outcomes, which is required for FDA approval."

The study, a retrospective analysis, used data from two hospitals in different U.S. cities. The tool showed strong performance in detecting

intracranial pressure within seconds. Over the course of a patient's admission, being in the top 25% of intracranial pressure measurements was linked to a 24-fold increase in the risk of a subdural hemorrhage and a seven-fold increase in the likelihood of needing a craniectomy (a surgical procedure to relieve pressure on the brain).

The researchers note that the data linking to clinical outcomes is correlational and not causative, and further research is needed to fully establish causality. Next, they plan to conduct further validation studies, including those focused on identifying patients with neurological conditions in the ICU. Additionally, they hope to apply for breakthrough device status with the FDA, possibly bringing this life-saving technology closer to widespread clinical use.

"Our vision is to integrate this tool into ICUs as a standard part of monitoring critically ill patients. This technology represents a major leap forward, potentially transforming how we manage critically ill patients, reducing the need for risky procedures and enabling faster responses to neurological emergencies," says senior author Girish Nadkarni, MD, Ph.D., Irene and Dr. Arthur M. Fishberg Professor of Medicine at Icahn Mount Sinai, Director of The Charles Bronfman Institute of Personalized Medicine, and System Chief, Division of Data-Driven and Digital Medicine.

"In addition, our findings suggest it could be a valuable tool not only in neurology but also in managing other severe health conditions, such as post-cardiac arrest, glaucoma, and acute liver failure."

"Our team's development of this AI-driven clinical decision support tool could be a significant step forward in advancing health outcomes for critically ill patients. If we can validate the use of this tool, we have the potential to improve patient safety by fine-tuning the use of invasive intracranial invasive monitoring in patients with the greatest potential for

benefit," says study co-author David L. Reich, MD, President of The Mount Sinai Hospital and Mount Sinai Queens, the Horace W. Goldsmith Professor of Anesthesiology, and Professor of Artificial Intelligence and Human Health at Icahn Mount Sinai.

"One of our goals at Mount Sinai is using technology to bring the right team to the right patient at the right time. This tool exemplifies that commitment, offering a tailored solution that has the potential to improve the standard of care for patients at risk of life-threatening brain injuries."

More information: Faris Gulamali et al, Derivation, external and clinical validation of a deep learning approach for detecting intracranial hypertension, *npj Digital Medicine* (2024). DOI: 10.1038/s41746-024-01227-0

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