Development of a non-invasive Intracranial Pressure (nICP) Monitor for Neurocritical Care Patients

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1. Head Injuries in UK
   - 1.4 Million A&A attendance per year in England and Wales
   - 50% Children aged under 15 years
   - 20% Skull fracture or brain damage
   - 40% Survivors dye after 13 years from the injury
   - Estimated costs per year of £15bn
   - 50% Children aged under 15 years in UK
   - 20% Survivors dye after 13 years from the injury
   - 40% Estimated costs per year of £15bn

2. The ‘ICP’
   - The Intracranial Pressure (ICP) is the pressure surrounding the brain within the close cavity of the skull.
   - After a head injury, the ICP can rise rapidly and can cause disastrous consequences such as death or long term disabilities.
   - The only way to measure the ICP is by inserting a small pressure sensor through a surgical opening in the skull. The procedure can cause infections or brain damage.

3. The nICP Monitor
   - The nICP monitor is a completely non-invasive device which works by shining harmless near-infrared light into the brain.
   - The light travels through the skin, skull and brain and returns back to the sensor which records the brain pulsations.

4. The nICP Sensor
   - nICP Sensor
   - Inlet (from pump)
   - Outlet
   - Intracranial chamber
   - Extracerebral fluid (pressurised to simulate ICP)
   - Skull layer
   - Vascular bed
   - Brain Phantom

5. In Vitro Tests
   - We have tested our nICP monitor in an in vitro model that simulates the cerebral circulation and it is capable of recreating the intracranial pressure around the brain.
   - The model contains a pump that replicates the action of the heart, arteries made of silicon and a brain phantom in an intracranial chamber.
   - We carried out measurements in the model by placing our nICP sensor on the brain phantom and measured the nICP signal during different levels of ICP.

6. nICP vs. ICP
   - By using feature extraction techniques and a Machine Learning Regression Model, we were able to use the nICP signals to predict the intracranial pressure with a good accuracy of 2.4 mmHg.

7. Clinical Trial
   - A clinical evaluation of the nICP monitor is currently underway on trauma patients at the Royal London Hospital.
   - In this study, we are comparing the invasive and non-invasive ICP monitors to assess if the nICP monitor can replace the invasive ICP.